Always On™
UPS Systems Inc.

Borealis Series
Three Phase ELI System

8 KW – 48 KW

Service Manual

NOTE

The instructions contained in this manual are not intended to cover all of the details or variations in equipment, or to provide for every possible contingency to be met in connection with installation, operation, or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred directly to Always On.

Any electrical or mechanical modifications to this equipment, without prior written consent of Always On, will void all warranties and may void UL/cUL listing. Unauthorized modifications may also result in personal injury, death, and damage to the equipment.

Dear Customer,

Thank you for selecting our emergency lighting inverter (ELI). We are pleased to include you as one of our valued Always On customers!

We are confident that this emergency lighting inverter system, developed and manufactured in our ISO 9001 certified facilities, will provide the quality and satisfaction you demand.

Please read this installation manual carefully as it contains the necessary information required to install the ELI properly.

Thank you for choosing Always On.

Preface

Congratulations on your choice of our emergency lighting inverter (ELI).

This equipment has been manufactured and tested using methods and procedures equivalent to UL 924.

This manual describes the recommended procedures for installing the ELI.

While every effort has been made to ensure the completeness and accuracy of this manual, Always On assumes no responsibility or liability for any losses or damages resulting from the use of the information contained in this document.

WARNING: This manual is intended to provide installation instructions only. The information contained in this manual is to be used as a guideline and recommendation only. Only qualified personnel should perform installation and maintenance. Factory authorized personnel shall inspect installation prior to start up and commissioning to validate warranty. Failure to follow this directive will void the warranty.

We recommend that this manual be kept with the ELI for future reference. If any problems are encountered with the procedures contained in this manual, please contact our Service Centre before proceeding.

This document may not be copied or reproduced without the explicit written permission of Always On.

Due to technical advancements and improvements, some of the information contained in this manual may be changed or modified without prior notice.

Symbols

The following symbols are used through out this manual.

Warning Information

This symbol alerts you to important information.

Electrical Hazard

This symbol indicates an electrical hazard may be present.

Electrical Symbols

Protective grounding terminal; a terminal that must be connected to ground prior to making any other connection to the equipment.

A terminal to/from which an alternating current or voltage may be applied/supplied.

A terminal to/from which a direct current or voltage may be applied/supplied.

This symbol indicates the word “phase”.

Safety Instructions

READ AND FOLLOW ALL SAFETY INSTRUCTIONS. SAVE THESE INSTRUCTIONS.

This manual contains important safety instructions that should be followed during installation and maintenance of the NX Series ELI system and optional packages. Before the installation process begins, we recommend that the installer read through the safety precautions, operators manual and the option installation instructions, taking all necessary safety precautions to protect themselves and the equipment being installed.

GENERAL

- Move the ELI in an upright position, in its original packaging, to its final destination.
- To lift the cabinets, use a forklift or lifting belts with spreader bars.
- Check for sufficient floor and elevator loading capacity.
- Check the integrity of the ELI equipment carefully.
- If visible damage is evident, **do not** attempt to install or start the ELI. Contact the transport delivery company immediately, file a claim with the transport company and inform Always On directly.
- Do not use outdoors.
- The use of accessory equipment not recommended by Always On may cause an unsafe condition.
- WARNING! RISK OF ELECTRICAL SHOCK: use extreme caution when removing covers.
- All maintenance and service work should be performed by qualified and trained service personnel. The ELI may contain its own energy source, (batteries) which can be dangerous to the untrained person. This ELI contains potentially hazardous voltages
- The field-wiring terminals may be electrically live, even when the ELI is not connected to the utility.
- Use caution when servicing batteries. A battery can present a risk of electrical shock, burn from high short-current. Battery acid can cause burns to skin and eyes. If acid is spilled on skin or in eyes, flush with fresh water and contact physician immediately.
- When replacing batteries use the same number and type (sealed-cell lead acid).
- Proper disposal of batteries is required. Refer to your local codes for disposal requirements.
- Dangerous voltages may be present during battery operation. The batteries must be disconnected during maintenance or service work. (Open battery breaker or fuses)
- Do not use this equipment for other than intended use.

INSTALLATION

- This ELI is intended for use in a controlled indoor environment free of conductive contaminants and protected against any type of intrusion.
- Do not install the ELI in an excessively humid environment or near water.
- Avoid spilling liquids and/or dropping any foreign object(s) onto the ELI.
- The unit must be placed in a sufficiently ventilated area; the ambient temperature should not exceed 40°C (104°F).
- Optimal battery life is obtained if the ambient temperature does not exceed 25°C (77°F).
- HIGH GROUND LEAKAGE CURRENT: ground connection completed before connecting the AC voltage wires on the input!
- Switching OFF the ELI does not isolate the ELI from the utility as the utility supply is still HOT at the input terminal strip. Supply breaker needs to be opened.
- It is important that air can move freely around and through the unit. Do not block the air vents.
- Avoid locations in direct sunlight or near heat sources (gas or electric heaters).

STORAGE

- Store the ELI in a dry location free of contaminants;
- Storage temperature must be within -25°C (-13°F) to 55°C (131°F).
- If the unit is stored for a period exceeding 3 months, the batteries must be recharged periodically (time depending on storage temperature).

WARNING!
LETHAL VOLTAGES MAY BE PRESENT WITHIN THIS UNIT EVEN WHEN IT IS APPARENTLY NOT OPERATING. OBSERVE ALL CAUTIONS AND WARNINGS IN THIS MANUAL. FAILURE TO DO SO COULD RESULT IN SERIOUS INJURY OR DEATH. REFER UNIT TO QUALIFIED SERVICE PERSONNEL IF MAINTENANCE IS REQUIRED. NO ONE SHOULD WORK ON THIS EQUIPMENT UNLESS THEY ARE FULLY QUALIFIED TO DO SO. AN INSTALLER SHOULD NEVER WORK ALONE.

WARNING!
WHEN REMOVING POWER FROM THE ELI, ALLOW FIVE MINUTES FOR CAPACITORS TO DISCHARGE BEFORE WORKING ON THE EQUIPMENT.

CAUTION!
This equipment complies with the requirements in Part 15 of FCC rules for a Class A computing device. Operation of this equipment in a residential area may cause interference to radio and TV reception, requiring the operator to take whatever steps necessary to correct the interference.

CAUTION!
Do not put option control wiring in the same conduit as the ELI input or output power cables.

THIS SAFETY NOTICE IS ADDRESSED TO THE ALWAYS ON CUSTOMER ENGINEERS WHO PERFORM MAINTENANCE OF THE UNINTERRUPTIBLE POWER SUPPLY (ELI) SYSTEMS.

Electrical Safety

- Maintenance work to be performed by a factory trained customer engineers, or qualified personnel. Extremely dangerous voltage levels can exist within the ELI system. Extreme caution must be used.
- Ensure system is in maintenance bypass mode or external wrap-around bypass mode before work is started.
- This manual is designed as an aid tool in diagnosing problems that may arise. Always On does not assume responsibility if information causes injuries.
- Apart from the front door, do not open any other part of the ELI without consulting the factory first. Before removing the protection screens, be sure that the unit is completely powered off.
- Be aware that dangerous voltage can be supplied by the internal battery or electrolytic capacitors.
- When system is in bypass mode and all fuses have been opened dangerous voltages may exist within the ELI system. Use extreme caution when exchanging boards and working inside the unit.

READ AND FOLLOW ALL SAFETY INSTRUCTIONS.
SAVE THESE INSTRUCTIONS.

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1. Introduction

WARNING! The user of this manual must be factory trained and authorized to service three phase Always On ELI systems.

This manual is to be used in conjunction with the Operators Manual.

This manual is designed to aid in the understanding and identification of the major components. It will provide general information and layout of each major component and what assemblies are involved in the functionality of that specific component.

1.1. Definitions

- **Critical Load**
  These are loads that require clean, regulated and continuous AC power and which are connected to the output of the ELI module
- **ELI Module**
  The portion of the ELI system that contains one or more of: the rectifier / DFC, charger, inverter, static bypass switch, maintenance bypass switch, controls, monitoring, and indicators.
- **Rectifier / DFC**
  Contained in the ELI module. Responsible for converting the normal AC input power to DC power and supplying the inverter with DC power.
- **Charger**
  Contained in the ELI module. Responsible for recharging the batteries.
- **Inverter**
  Contained in the ELI module. Responsible for converting DC power (supplied by the rectifier) to regulated and filtered AC power that is then supplied to the critical loads.
- **Static Bypass Switch**
  Contained in the ELI module. Responsible for automatically transferring the attached load, without interruption, from the inverter AC output to the bypass AC power source in the event of an overload or degradation of the inverter's performance.
- **Maintenance Bypass Switch**:
  Contained in the ELI module. Used to transferring the attached load, without interruption, from the inverter AC output to the bypass AC power source while electrically isolating the static bypass switch, rectifier / DFC, charger and inverter. Used for maintenance purposes.
- **Battery**
  The battery system provides DC power to the inverter input when the normal AC input power to the ELI fails.
- **IGBT**
  Isolated Gate Bipolar Transistor.
- **PWM**
  Pulse Width Modulation.
- **ELI**
  Emergency Lighting Inverter.

Definitions Continued

- **BBU**
  Battery Backup Unit.
- **PFC**
  Power Factor Correction.
- **EPO**
  Emergency Power Off.

2. Theory of Operation

2.1. General Topology

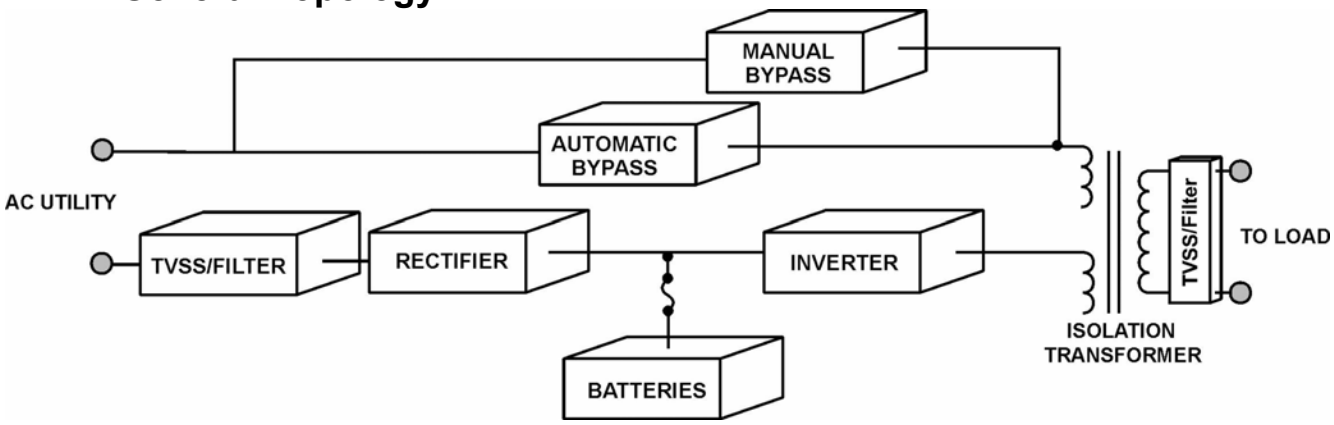


Figure 2.1
General Block Diagram

ELI Module Components: The ELI module consists of the following major components:

- Input, Reserve and Bypass circuit breakers
- Rectifier / Charger
- Inverter
- Microprocessor controlled logic and control panel with alarm indicators and digital metering display
- External battery connection
- Static bypass
- Full maintenance bypass
- Emergency power off (EPO) connection
- Communications interface
- SNMP Adapter for network communications and monitoring
- Input power walk-in
- Front cable connections
- Output isolation transformer
- Optional Features:
    - 12-pulse rectifier and harmonic filter to reduce input harmonic content.
    - Additional battery modules for extended runtime
    - Top cable entry
    - Remote display panel
    - Emergency power off switch
    - External maintenance bypass cabinet
    - Isolated parallel redundant operation (IPRO)

Generally, there are four modes of operation for an ELI system, NORMAL MODE, BACK-UP (BATTERY) MODE, RESERVE MODE and MAINTENANCE BYPASS MODE.

2.2. Normal Operation Mode

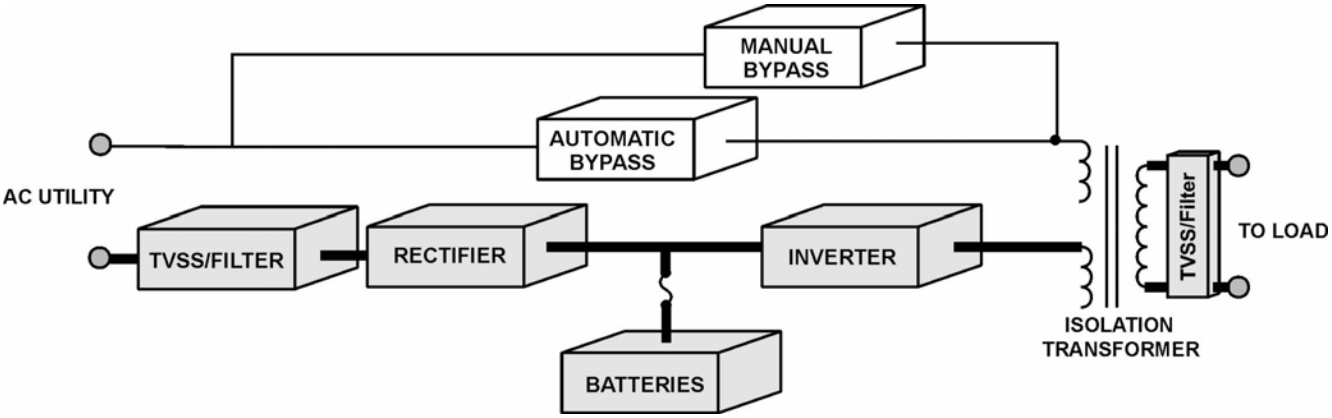


Figure 2.2
Normal Mode Operation

The rectifier/charger converts the supplied AC power into DC (bus) power that is then supplied to the inverter and the battery charger. The DC to AC inverter then supplies continuous, noise free AC power to the critical loads. The inverter output is synchronized with the bypass AC power source provided that the bypass AC power source is within the specified frequency range.

2.3. Backup Mode

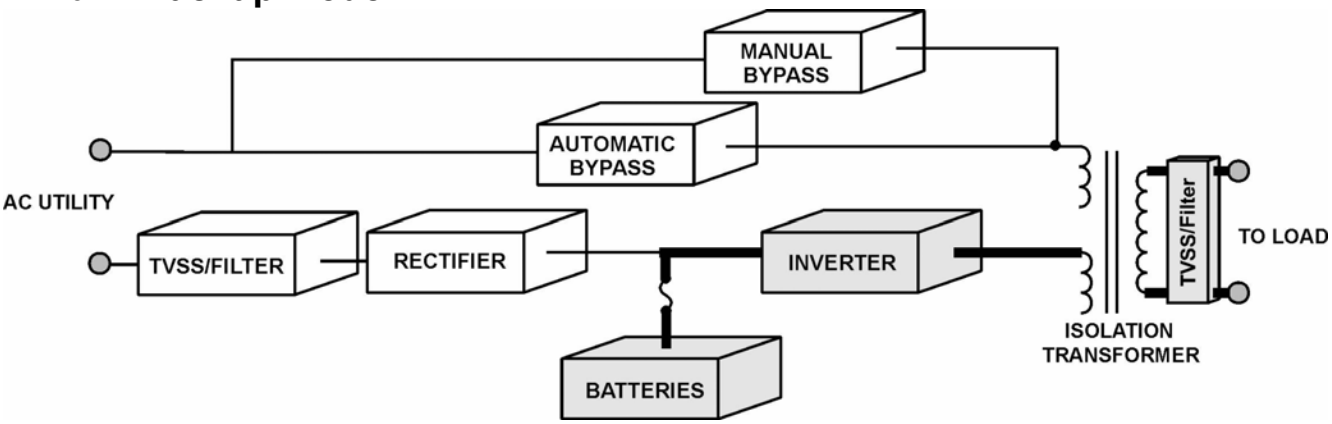


Figure 2.3
Back-up Mode Operation

As the batteries are connected to the DC bus they supply energy to the inverter via this DC bus, the AC power will remain constant and continuous without interruption to the loads when the AC fails or falls out side of the operating parameters. Upon return of the supplied AC input power the ELI the rectifier will automatically assume the DC load (charger, inverter) from the batteries. The ELI will simultaneously supply power to the inverter and the battery charger to replenish the batteries.

2.4. Reserve Mode

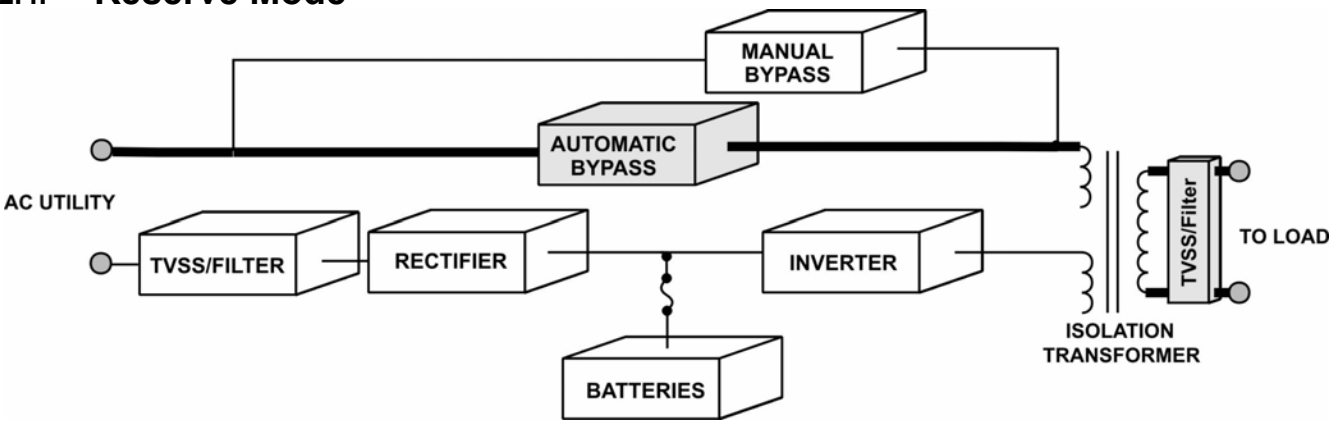


Figure 2.4
Reserve Mode Operation

If the inverter is placed into an abnormal condition, such as over temperature, short circuit, abnormal output voltage or is overloaded for a period which exceeds the inverter's limits, the inverter will automatically shutdown in order to protect itself. If the AC utility power is within the normal parameters, the static switch will automatically transfer the load to the reserve (utility) source without interruption of the AC output.

2.5. Manual Bypass Mode

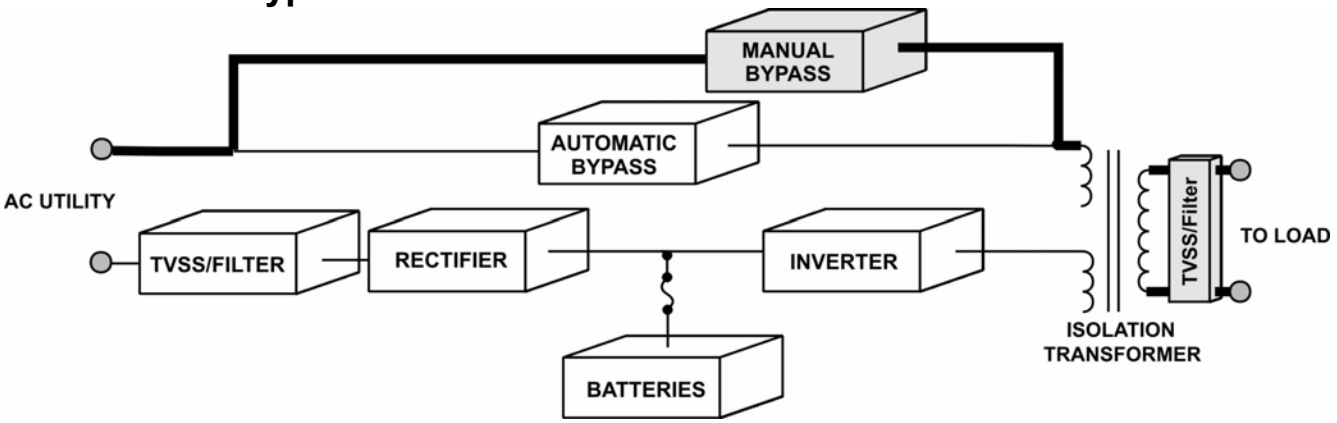


Figure 2.5
Manual Bypass Mode Operation

During ELI service procedures or battery replacement, the loads cannot be interrupted, and as such the technician needs to turn off the inverter switch, close the bypass breaker and then open the rectifier and reserve (utility) breakers. The ELI is now running in Manual By-pass mode supplying utility AC to the loads. The AC output will not be interrupted during the manual bypass transfer procedure because the manual bypass switch is designed to supply continuous power to the loads.

2.6. Rectifier

The main function of a rectifier is to convert the AC input power to DC power. The DC power is then used to charge the batteries, supply the DC bus, which in turn supplies the inverter.

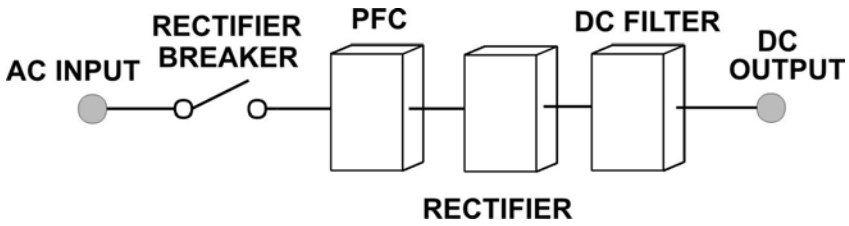


Figure 2.6
Rectifier Function

The rectifier design used in the 8KW to 48KW ELI's include a 6-pulse full controlled rectifier. Power Factor Correction (PFC) has been added to maintain a high input power factor, independent of the load power factor. This 6 pulse rectifier smoothes the current waveform and reduces the harmonic content reflected back to the utility. The control circuit regulates the DC bus to within 1% of the nominal voltage. Soft walk-in circuitry (approximately 20 seconds) and current limiting circuitry are used to prevent over current or surge currents from affecting any part of the ELI system.

Additionally, over and under-voltage protection is added to improve reliability and to shutdown the rectifier in the event of abnormal conditions. The DC bus is adjustable to allow for different types and capacities of batteries. The power components used within the rectifier are specially designed and selected to handle extreme ranges of high voltage and high current (–25% to +25%).

2.7. Inverter

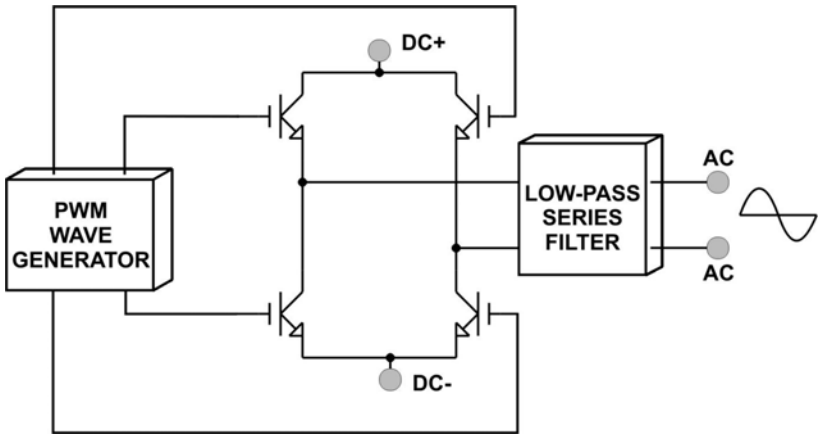


Figure 2.7
Inverter Layout

The inverter is composed of IGBT's, inductors, capacitors, highly efficient filters, control circuitry and protection circuitry. This inverter inverts the DC power received on the DC bus to isolated, noise-free AC power, which is then supplied to the critical loads. Our PWM wave generator is switching at a higher frequency well above the human audible range.

The Voltage regulating circuitry limits the output voltage variation to within 1% of the nominal voltage and special compensation circuitry has been added to eliminate output distortion. Every component is oversized to accept a wide DC input range (from 285 to 420VDC), allowing the output waveform to remain sinusoidal throughout the entire range. With the aid of dynamic feedback loop circuits the inverter maintains a true sine wave output, even if non-linear loads are connected.

The system is designed and incorporates an independent inverter per phase. These inverters are totally independent of each other preventing the possibility of cascading failures. This allows the user to connect loads to adjacent inverters without affecting the other inverters providing high-end voltage regulation under a 100% unbalanced load situation.

The IGBT is operated in its optimal condition to obtain maximum efficiency, keeping electrical costs to a minimum.

Usually, most ELI failures are a result of inverter failures. To prevent this occurrence, Always On has included redundant protection circuitry to protect the inverter and increase its reliability. To enhance this protection we have also added a high efficiency filter designed to suppress the spikes and noise that can be reflected from the attached loads *back into* the ELI system. Specifying oversized and high quality components, additional semi-conductor fuses and allowing for good ventilation systems within further increase reliability.

2.8. Static Switch

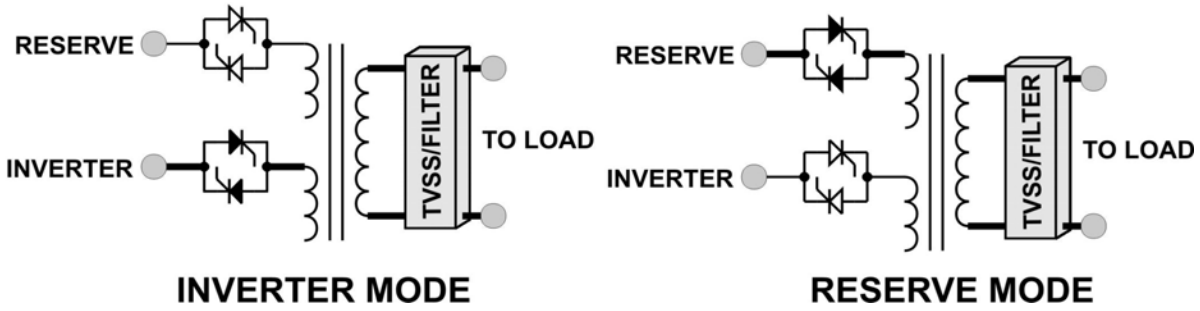


Figure 2.8
Static Bypass

The static switch is composed of two pairs of back to back naturally commutated SCR's, which moves the load from inverter to reserve (utility) or from reserve to inverter without interruption of power to the load.

Detection circuitry is included in the control circuit to achieve "0" dead time transfer. Additional detection is employed to control the static switch transfer.

Dead Short: If a dead short circuit was to occur under normal mode operation, the ELI would detect the short circuit and immediately stop the inverter until the problem has been rectified. Due to the large amount of current a dead short requires, the static switch will not transfer to reserve preventing the tripping of the reserve breaker.

Overload condition: The ELI will transfer the load to reserve (utility) path. The static switch is designed to handle 110% of the capacity of the system, but will switch to the reserve path if the overload continues for the specified length of time. The load will be operational, but in the event of a utility failure the inverter has been shutdown therefore no battery time is available until the overload is removed and inverter is allowed to reset.

The static switch will only be activated if the input levels are within parameters to ensure the load is only supplied with acceptable power to protect against damage that may be caused to the critical load. The system performs numerous checks on the transfer from inverter to bypass and visa versa to ensure the exchange is smooth.

2.9. Manual Bypass Switch

The manual bypass switch is a function of Always On ELI's that is open under normal operation, and closed for service. All power supplied to the ELI should be disconnected before service begins. The manual bypass is switched seamlessly to supply utility AC power to the loads during ELI servicing. If the bypass breaker is closed (by mistake) under normal operations, the inverter will stop and the load will be transferred to reserve (utility) power.
The inverter cannot be turned on when the maintenance bypass breaker is in the closed position.
(The operation of the manual bypass breaker is explained later in this manual)

3. Front Panel

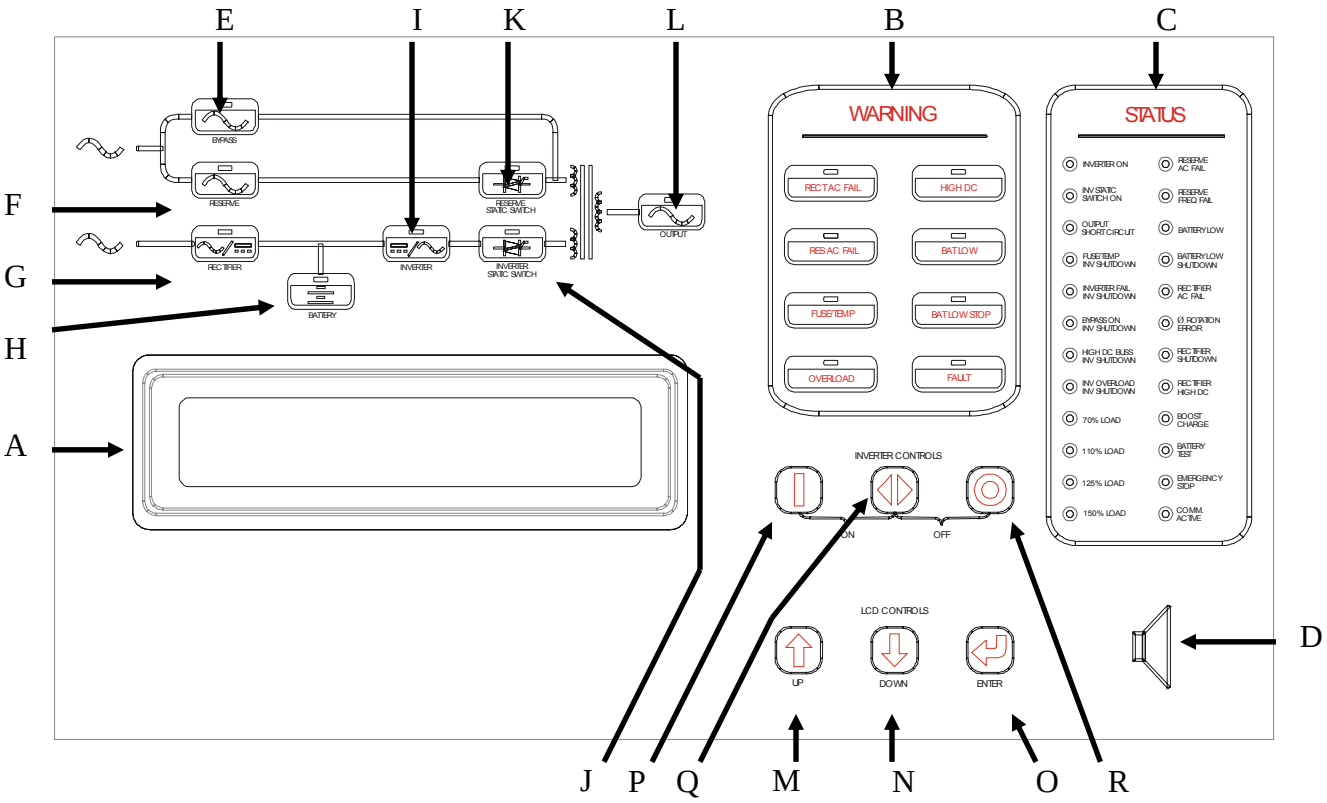


Figure 3.1
Front Panel

The front panel is located behind the glass window on the front of the ELI system. It displays the real time information and status of the ELI and battery system. It also provides for user interface for controlling and setting the ELI operating status. This panel also allows the user to operate and monitor the system with ease. The panel is explained below:

A: LCD display- Real time status, data and historical events are displayed on the LCD. The ELI parameters, real time clock, inverter, and buzzer can also be set through this LCD. The LCD is back lit by LED's for a sharper display, but in order to lengthen the LED's life time, the LED will automatically shut off 3 minutes after a key has been pressed, and will light up again when one of the up/down/enter keys are pushed.

B: Warning LED's-When an abnormal condition occurs, these LED's will illuminate allowing the user to identify the fault. This will also allow the service personnel the ability to troubleshoot the system. These LED's are described below:

- **RECT AC FAIL –** when the supply to the rectifier is outside of the operating parameters. This not only applies to voltage range but also when phase rotation is incorrect or the rectifier has been shutdown (refer to **C: Status LED's**).

- **RES AC FAIL –** supply to the reserve is outside of the operating parameters. Supply voltage or frequency out of range (refer to **C: Status LED's**).
- **FUSE/TEMP –** inverter has shutdown due to inverter fuse open or heat sink temperature above operating parameters.
- **OVERLOAD –** an overload condition has occurred on the output.
- **HIGH DC –** this LED will be lit as long as the DC voltage exceeds 430VDC.
- **BAT LOW –** this LED will be lit as long as the DC voltage is lower than 320VDC.
- **BAT LOW STOP –** the LED will be lit as long as the DC voltage is lower than 295VDC. The inverter will not activate until the DC voltage is above this level.
- **FAULT –** the inverter has shutdown because an abnormal condition has occurred. Possible conditions include overload, short circuit, high DC shutdown, fuse/over temperature, bypass breaker on or emergency stop (refer to **C: Status LED's**).

C: Status LED's- 24 LED's represent the real-time information regarding the status of the ELI system. These LED's will aid in diagnosing and trouble shooting abnormal conditions. The 24 LED's represent the following:

- **INVERTER ON –** inverter is running.
- **INV STATIC SWITCH ON –** inverter static switch is active.
- **OUTPUT SHORT CIRCUIT –** ELI output is in a short circuit state.
- **FUSE/TEMP INV SHUTDOWN –** inverter has shutdown due to inverter fuse open or heat sink temperature above operating parameters.
- **INVERTER FAIL INV SHUTDOWN –** inverter has shutdown due to inverter output voltage below tolerances.
- **BYPASS ON INV SHUTDOWN –** inverter has shutdown because the bypass breaker has been activated while the inverter is supplying power to the load.
- **HIGH DC BUSS INV SHUTDOWN –** inverter has shutdown because the DC Bus voltage is outside of operating parameters while the inverter is operating.

- **INV OVERLOAD INV SHUTDOWN –** inverter has shutdown because an overload condition has been detected on the output. The inverter will automatically restart after the condition has been removed for a period of seven seconds.
- **70% LOAD –** load connected to the output is over 70% of the ELI rating.
- **110% LOAD -** load connected to the output is over 110% of the ELI rating.
- **125% LOAD -** load connected to the output is over 125% of the ELI rating.
- **150% LOAD -** load connected to the output is over 150% of the ELI rating.
- **RESERVE AC FAIL –** supply voltage to the Reserve is outside of operating window.
- **RESERVE FREQ FAIL –** supply frequency to the Reserve is outside of operating window.
- **BATTERY LOW –** the DC bus (or battery) voltage is lower than 320VDC. Low battery shutdown is approaching.
- **BATTERY LOW SHUTDOWN –** the inverter has shutdown because the DC bus (or battery) voltage is below operating level (lower than 295VDC).
- **RECTIFIER AC FAIL –** supply to rectifier is outside of operating window.
- **Ø ROTATION ERROR –** supply phase rotation is outside of operating window.
- **RECTIFIER SHUTDOWN –** the rectifier has shutdown because the DC bus voltage has exceeded maximum operating level (over 445VDC). The rectifier will automatically restart 30 seconds this abnormal condition has been cleared.
- **RECTIFIER HIGH DC –** the DC voltage has exceeded maximum operating level (over 430VDC). The bus voltage is limited to this voltage.
- **BOOST CHARGE –** the batteries are being boost charged by the rectifier.
- **BATTERY TEST –** batteries are being tested.
- **EMERGENCY STOP –** the inverter has shutdown because the emergency stop switch has been activated.
- **COMM. ACTIVE –** blinks when data is being transmitted or received via the communication port.

D: Buzzer outlet: There is a buzzer located behind the LCD Display. The buzzer will allow for audile notification during an abnormal condition. The buzzer will be activated under one of the following conditions: (The frequency of the buzzer is also described for your reference.)

• **INVERTER IS OVERLOADED**	>110%, beep once / 3 seconds >125%, beep once / second >150%, beep twice / second
• **BACK-UP**	>320VDC, beep once / 3seconds <320VDC, beep twice / second <295VDC, no beeping
• **INVERTER IS SHORT CIRCUITED**	beep continuously
• **FUSE BROKEN**	beep continuously
• **HEAT SINK OVER TEMPERATURE**	beep continuously
• **HIGH DC SHUTDOWN**	beep continuously
• **BYPASS ON STOP**	beep continuously
• **EMERGENCY STOP**	beep continuously

The buzzer will beep once every time the inverter is switched on or off. This will allow for the user to be sure the operation was performed correctly.

E. Bypass LED: This LED is lit when the maintenance bypass breaker is closed leaving the inverter in the off mode. If the inverter is active when the bypass breaker is closed the inverter will shutdown immediately.

F. Reserve LED: This LED is lit when the reserve breaker is closed, and the supply is within operating parameters.

G. Rectifier LED: This LED is lit when the rectifier is operating, the supply is within operating parameters, the rectifier breaker is closed and the DC bus voltage is within operating parameters.

H. Battery LED: This LED is lit while the ELI is in back-up mode. This LED also indicates the results of battery test. If the battery pack does not pass the test, this LED will flash prompting the user to change the battery pack.

I. Inverter LED: This LED is lit when the inverter is supplying power to the load.

J. Inverter Static Switch LED: This LED is lit when the inverter static switch is operating and the reserve static switch is turned off. When this LED is on, the load is supplied from the inverter. Usually this LED will stay lit for 7sec. after the inverter is switched on.

K. Reserve Static Switch LED: This LED is lit when the reserve static switch is operating and the inverter static switch is turned off. When this LED is on, the load is being supplied by the reserve. Since the reserve static switch and inverter static switch will never operate simultaneously, the Inv Static Switch On LED and the Reserve Static Switch LED will never be lit at the same time.

L. Output LED: This LED is lit when there is AC power present at the output terminals.

M. Up key: This is an LCD control key. It moves the cursor one field upward when items are being selected or changes the number/character forward when data or parameters of the ELI are being set.

N. Down key: This is an LCD control key. It moves the cursor one field downward when items are being selected or changes the number/character backward when data or parameters of the ELI are being set.

O. Enter key: This is an LCD control key. It returns to the previous page, and also confirms the number/character/item selected.

P. Inverter "On" Switch: This is an inverter control switch. When this switch is pushed simultaneously with the control key, the inverter will switch on.

Q. Inverter "Control" Switch: This is an inverter control switch. When this switch is pushed in conjunction with the inverter "On" switch the inverter will activate. Similarly, when this switch is pushed with the inverter "Off" switch the inverter will shutdown. This switch acts as a safety switch to prevent accidental operation of the inverter.

R. Inverter "Off" Switch: This is an inverter control switch. When this switch is pushed simultaneously with the control switch the inverter will be turned off.

4. Operation

After all the cables have been connected and power is present at the input terminal, the ELI is ready to operate. Before initial start-up, re-check the following:

- **a.** Make certain there is no foreign material left on, inside or around the ELI
- **b.** Ensure all breakers and the battery disconnect switches are **opened**
- **c.** Ensure all loads are switched off.
- **d.** Check that the input frequency matches the ELI's rated input frequency
- **e.** Check that the input voltage matches the ELI's rated input voltage

4.1. Switch On Procedure (Authorized Trained Personnel Only)

These start-up procedures can be performed with the AC utility source connected to or with only the batteries connected.

a. *Close the input breaker* – Energize the transformer.

b. *Close the reserve breaker* – The reserve and output LED on the status panel will light up, indicating the reserve static switch loop is energized and there is power on the output terminals. The power supplies within the ELI will energize and the internal fans will rotate.

c. *Close the rectifier breaker* - The rectifier will automatically start if the AC utility power connected is within operating parameters. The DC voltage will slowly rise (15 – 30 sec.) until the designated voltage is reached. The DC voltage is now ready for the inverter and battery bank.

d. *Close the battery breaker holder* - A breaker between the battery bank and the ELI is used for safety purposes. The batteries will start charging once the fuse door or breaker is closed. This fuse holder can be located within the ELI system or within the battery cabinets depending on rating.

e. *Push inverter on switch* – To turn on the inverter simultaneously press the inverter on switch (I) and the control switch (◄►). The inverter will begin to function with inverter output within 4 sec. The load will automatically transfer to the inverter 3 sec. later. The ELI is now operating in normal mode.

f. Check the status panel for correctness as shown in the diagram on the next page. All warning LED's on the right hand side are off, two LED's: 'INVERTER ON' and 'INVERTER STATIC SWITCH' on the left hand side should be lit, and the LED's circle should also be lit. If the load is over 70%, the '70% LOAD' LED will also be lit.

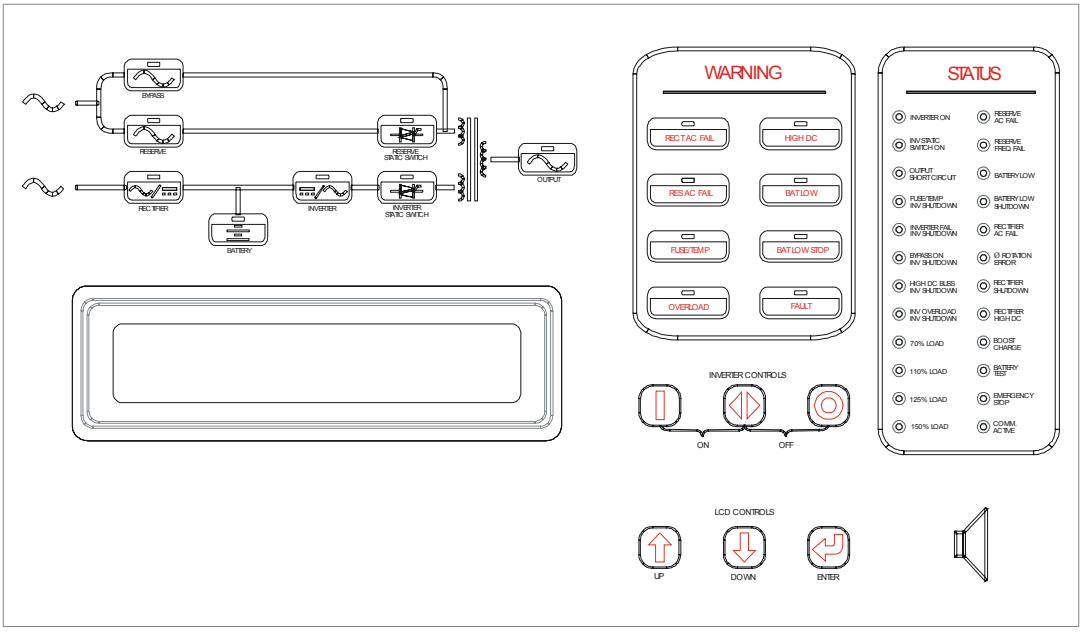


Figure 4.1
Status Panel Display Under Normal Operation
Circles represent LED's that are on.

4.2. Shutdown Procedure

To **completely shutdown** the ELI, please follow the following steps.

a. *Switch off the inverter* – The inverter can be switched off by simultaneously pressing the inverter off switch (**O**) and the inverter control switch (◄►). The load will be automatically transferred to reserve without interruption.

b. *Open the battery breaker* – This will disconnect the batteries from the DC bus and the ELI no longer has back up available. This is located within the ELI system or within the battery cabinets.

c. *Open the rectifier breaker* – Opening the rectifier breaker will remove the power source from the DC bus. The DC bus will start to drop slowly until it reaches a save level of approximately 20VDC.

WARNING!
Completing the next step will turn off the power to the loads.
Make sure all loads have been turned off before proceeding or the external wrap-around bypass has been initiated.

d. *Open the reserve breaker* – Before opening the reserve breaker you must make sure there is no critical load connected to the ELI that requires power. NO OUTPUT POWER WILL BE SUPPLIED FROM THE ELI ONCE THE RESERVE (UTILITY) BREAKER IS OPENED.

e. *Open the input breaker* – transformers will de-energized.

f. Now that all power has been cut off within the ELI system. All LED's, displays and fans should be off.

> **CAUTION!**
> Terminal strip and breakers may still be energized if the main input breaker feeding the ELI system is not turned off or open.

4.3. From Inverter To Manual Bypass Procedure

The following procedures will allow the service personnel to switch the ELI system to maintenance bypass mode without interrupting the output power to the loads.

a. *Switch off the inverter* – The inverter can be switched off by simultaneously pressing the inverter off switch (**O**) and the inverter control switch (◄►). The load will be automatically transferred to reserve (utility) supply without interruption.

b. *Open the battery breaker* – This will disconnect the batteries from the DC bus and the ELI no longer has back up available. This is located within the ELI system or within the battery cabinets.

c. *Open the rectifier breaker* – Opening the rectifier breaker will take the power source away from the DC bus, therefore, the DC bus will start to drop slowly. After 5 min., the DC bus will drop to a safe level (approx. 20VDC).

d. *Close the bypass breaker* – The reserve breaker and reserve static switch are still conducting. When the maintenance bypass breaker is closed, power will flow through the bypass loop instead of the reserve loop because the impedance of the bypass loop is lower.

e. *Open the reserve breaker* – You can now open the reserve breaker to cut off any power within the ELI electronics.

NOTE: To place the unit into Maintenance Bypass mode the fuse holders behind the control module (where all control PCB's are stored) must be opened.

The system is now in Manual Bypass mode (or Maintenance Bypass mode).

> **CAUTION!**
> If fuse holders have not been opened power still present and fans will be turning. If fuse holders open power is still present at the terminal strip and several terminals on the PCB's.

4.4. From Manual Bypass to Inverter Procedure

After the maintenance procedures and testing are complete you will need to restore the ELI back to its normal mode of operation without interrupting the power to the loads.The following procedures need to be followed.

a. *Close all fuse holders* – ensure all fuse holders behind the control module are closed. Fans will start spinning.

b. *Close the reserve breaker* – Wait 15 seconds for the reserve and output LED on the status panel to light up, indicating the reserve static switch loop is energized and there is power on the output terminals. The power supplies within the ELI will also energized and the internal fans will rotate.

c. *Open the bypass breaker* – The inverter cannot be switched on when the maintenance bypass breaker is closed (because the CPU will sense the breaker and prevent the inverter from connecting directly to the AC source). The reserve breaker is already closed so power goes through the reserve loop if the bypass breaker is open. AC power at the output will not be interrupted.

d. *Close the rectifier breaker* - The rectifier initiates automatically if the AC utility power connected is with in operating parameters. The DC voltage will slowly rise (15 – 30 sec.) until the designated voltage is reached. The DC voltage is now ready for the inverter and battery cabinets.

g. *Close the battery breaker* - A fuse holder is employed from the battery to the DC bus for safety purposes. The batteries will start charging once the breaker is closed. The breaker can be located within the battery cabinets.

h. *Push inverter on switch* – To turn on the inverter simultaneously press the inverter on switch (I) and the control switch (◄►). The inverter will start working and the inverter output will be established in 4 sec. The load will automatically transfer to the inverter 3 sec. later. The ELI is now operating in normal mode.

e. Check the status panel is correct, as shown in the diagram on the previous page. All warning LED's on the right hand side are off, two LED's: 'INVERTER ON' and 'INVERTER STATIC SWITCH' on the left hand side should be lit, and the LED's circle should also be lit. If the load is over 70%, the '70% LOAD' LED will also be lit.

4.5. Manual Battery Test

To initiate a manual battery test turn off the input breaker to disconnect all ungrounded conductors. This process will simulate a failure of utility supply.

4.6. Battery Condition Test

To be performed by service personnel. Consult service manual for more information.

5. The LCD Display

The LCD displays Real Time information as to the status and operation characteristics of the UPS system and battery banks. In order to make the display sharp and readable, the LCD is back-lit by LED's. To prolong the life of the LED, the CPU will cut off the power of the LED 3 minutes after the last key has been pressed. The backlight will illuminate whenever a key has been pressed. This screen will pop up once the system power is enabled (i.e. the default screen).

5.1. Menu 0 – Main Menu

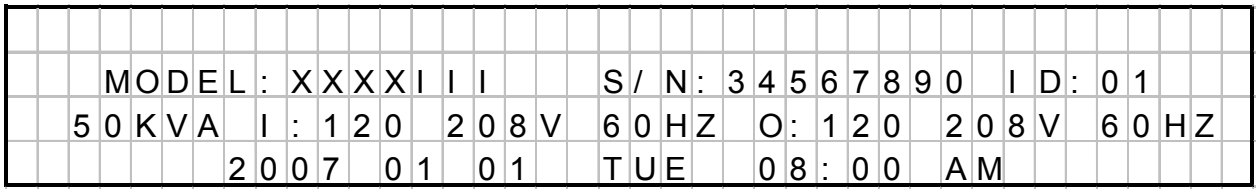


Figure 5.1
Main Menu Display

The first row will display the greeting content set by the factory. The model no. (MODEL), serial no. (S/N), and the identification no. (ID) are displayed in the second row. The third row will display the kVA rating, input rating and output rating of the UPS.

The serial no. is set by the factory for the convenience of maintenance personnel who may need to refer to the serial number for the correct spare parts and testing procedures. The identification no. is set only when multiple UPS systems are connected in parallel. Each UPS must have a unique number to identify itself, and will be set by a factory trained technician after installation. The YEAR/MONTH/DATE, DAY OF THE WEEK, HOUR, MINUTE and AM/PM from the real time clock inside the UPS are displayed in the fourth row for user's reference and for stamping the date and time in the historical data when an abnormal conditions occurs. By pressing one of the UP(↑), DOWN(↓) or ENTER(↵) keys, the LCD will change to another screen.

5.2. Menu 1 – Select Menu

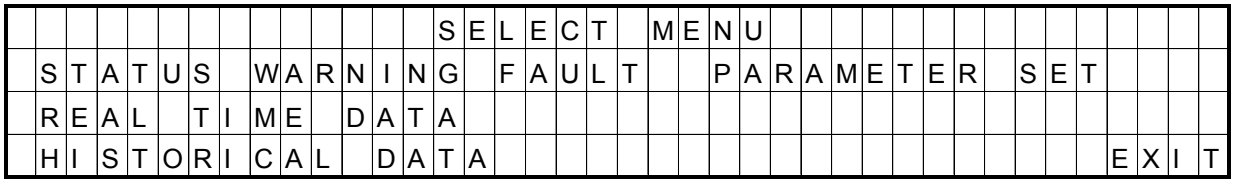


Figure 5.2
Select Menu Display

MENU 1 is reached by pressing any button on the opening screen and is also the default menu. From this menu the personnel can select STATUS WARNING FAULT, REAL TIME DATA, HISTORICAL DATA and PARAMETER SET menus. To select an option move the cursor (→) by pressing the UP (↑) key, or the DOWN (↓) key. Selections are confirmed by pressing the ENTER (↵) key. The user will be sent to the menu the cursor is pointing to. If the item 'PARAMETER SET' is selected, the LCD will jump into a screen that will prompt the user for a password. Contact service provider for more information.

5.3. Menu 2 – Status Warning Menu

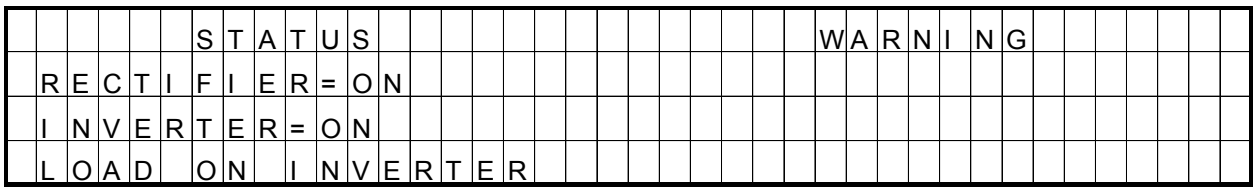


Figure 5.3
Status Warning Menu Display

The Status/Warning menu is accessed through MENU 1 by selecting STATUS WARNING FAULT. The left-hand side of this menu shows the real time status of the rectifier, inverter and static switch, while the right hand side shows the warning or fault condition if any. Under normal condition, the LCD display should be exactly the same as the figure shown above. When abnormal conditions occur it will be shown under the title < WARNING >, but this will be overridden by a "fault" message if more serious abnormal conditions occur and the title < WARNING > will then change to < FAULT >.

For example, if a short circuit has occurred, this screen will display as follows:

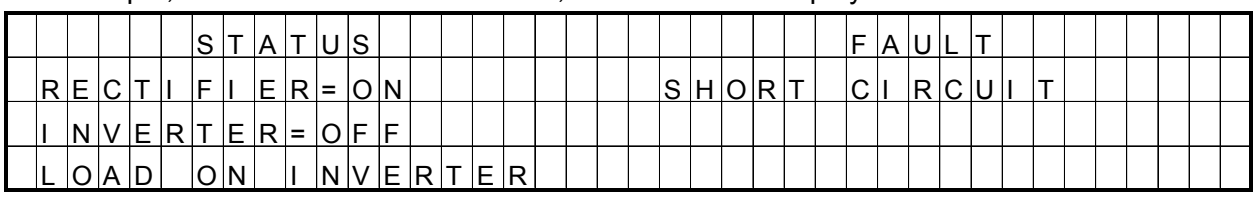


Figure 5.4
Warning Status Display with Fault Condition

The inverter will automatically shut off under a short circuit fault. The CPU is designed to detect short circuits and in order to avoid unnecessary tripping of the reserve (utility supply) breaker, the static switch will remain open or inactive. (There will be no output power present)

Listed below are all the warning conditions that can be displayed (they are arranged in order of priority, starting with the highest priority):

1st row: *BYPASS ON* – Output is being supplied by the reserve
RECT AC FAIL – AC utility source failure
RECTIFIER PHASE ERROR – AC utility phase loss or one phase out of operating parameters
RESERVE FREQ. ERROR – AC utility frequency is out of parameters and reserve has been disabled until error is corrected

2nd row: *170% OVERLOAD* – over 170% maximum capacity for the ELI system.
150% OVERLOAD – over 150% maximum capacity for the ELI system.
125% OVERLOAD – over 125% maximum capacity for the ELI system.
110% OVERLOAD – over 110% maximum capacity for the ELI system.

3rd row: *BATTERY LOW STOP* – Battery have been exhausted.
BATTERY LOW – Batteries have passed the low voltage level and will soon be exhausted.
BATTERY BAD – One or more cells have tested faulty.
BATTERY GND FAULT – Battery cabinet not grounded properly.
BATTERY TESTING – performing test on the batteries.

Listed below are all the fault conditions that can be displayed:

1st row: *HIGH DC SHUTDOWN* – DC Bus voltage out of operating range.

2nd row: *SHORT CIRCUIT!* – a short circuit condition has occurred on the output.
FUSE/OVERHEAT – a fuse has blown or the system has shutdown due to overheating.
OVERLOAD SHUTDOWN – system has exceeded the overload limit beyond the operating window.
EMERGENCY STOP – user has activated the emergency stop feature.
INVERTER ABNORMAL – inverter is not operating within specified parameters.

3rd row: *BYPASS ON SHUTDOWN* – inverter failure, system operating in bypass mode.

The UP (↑) or DOWN (↓) key has no function in this menu. The screen will go back to MENU 1, when ENTER (↵) is pressed.

5.4. Menu 3 – Real Time Data Menu

```
                REAL TIME DATA
 RECTIFIER DATA          OTHER DATA
 RESERVE DATA
 OUTPUT DATA                    EXIT
```

Figure 5.5
Real Time Data Menu Display

MENU 3 is reached by selecting REAL TIME DATA on MENU 1. The cursor(→) is used to select what type of real time data the user would like to view, RECTIFIER DATA, RESERVE DATA, OUTPUT DATA and OTHER DATA. To select one of the different menu options move the cursor(→) until it is pointing at the correct selection, by press the UP (↑) key or the DOWN (↓) key. To confirm and select the menu option press the ENTER (↵) key.

Selecting the 'EXIT' option (blinking instead of pointed by cursor) will return you to MENU 1.

Rectifier Data Menu

```
              RECTIFIER DATA >
      RECTIFIER FREQUENCY=XX HZ
 R-N=XXX Vac S-N=XXX Vac T-N=XXX Vac
```

Figure 5.6
Rectifier Data Menu Display

This menu is reached by selecting RECTIFIER DATA on MENU 3. The information provided on this menu is the real time readings of the rectifier input; RECTIFIER FREQUENCY, R-N/S-N/T-N VOLTAGE for wye (Y) configured systems or R- S/S-T/T-R VOLTAGE on delta (≥) configured systems.

The UP (↑) or DOWN (↓) key has no function in this menu. The screen will return to MENU 3 when the ENTER (↵) key is pressed.

Reserve Data Menu

```
            < RESERVE DATA >
      RESERVE FREQUENCY=XX HZ
 R-N=XXX Vac S-N=XXX Vac T-N=XXX Vac
```

Figure 5.7
Reserve Data Menu Display

This menu is reached by selecting RESERVE DATA on MENU 3. The information provided on this menu is the real time readings of the reserve input; RESERVE FREQUENCY, R-N/S-N/T-N VOLTAGE for wye (Y) configured systems or R- S/S-T/T-R VOLTAGE on delta (≥) configured systems.

The UP (↑) or DOWN (↓) key has no function in this menu. The screen will return to MENU 3 when the ENTER (↵) key is pressed.

Output Data Menu

```
                OUTPUT DATA
              OUTPUT FREQUENCY = XX HZ
        LOAD: R= XXX % S= XXX % T= XXX %
  R-N= XXX Vac  S-N= XXX Vac  T-N= XXX Vac
```

Figure 5.8
Output Data Menu Display

This menu is reached by selecting OUTPUT DATA on MENU 3. The information provided on this menu is the real time readings of the inverter or reserve output (depending on what mode the system is in); OUTPUT FREQUENCY, LOAD % OF R/S/T, OUTPUT R-N/S-N/T-N VOLTAGE for wye (Y) configured systems or R- S/S-T/T-R VOLTAGE on delta (∆) configured systems.

The UP (↑) or DOWN (↓) key has no function in this menu. The screen will return to MENU 3 when the ENTER (↵) key is pressed.

Other Data Menu

```
                OTHER DATA
          TEMPERATURE = XX °C
          DC VOLTAGE = XXX Vdc
          CHARGE CURRENT = XXXA
```

Figure 5.9
Other Data Menu Display

This menu is reached by selecting OTHER DATA on MENU 3. The information provided on this menu is the real time readings of the ELI system; TEMPERATURE, DC VOLTAGE, CHARGE OR DISCHARGE CURRENT.

When the ELI system is operating in normal mode the last line will read CHARGE CURRENT and will represent the amount of current being supplied to the batteries.

When the system changes to back-up mode the last line will change to DISCHARGE CURRENT displaying how much current is being supplied to the inverter from the batteries (figure below).

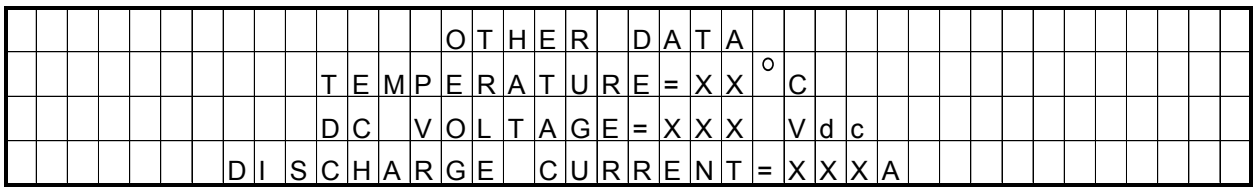


Figure 5.10
Other Data Menu Display when system in Back-up

The UP (↑) or DOWN (↓) key has no function in this menu. The screen will return to MENU 3 when the ENTER (↵) key is pressed.

5.5. Menu 4 – Historical Event Menu

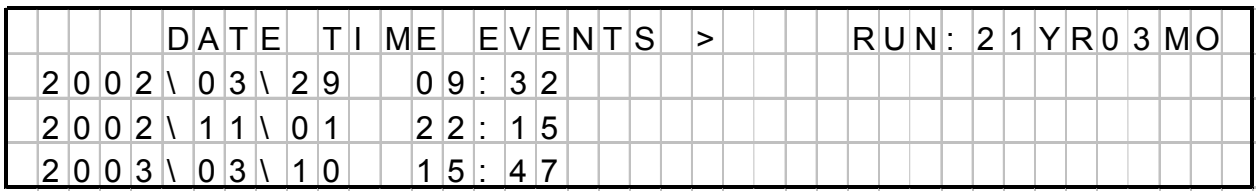


Figure 5.11
Historical Event Menu Display

MENU 4 is reached by selecting HISTORICAL DATA on MENU 1. All abnormal events are stored on the EEPROM and viewed through this menu based on the time each event occurred. The record display starts with the date and time stamp allowing the user or maintenance personnel to trace back that occurrence. A maximum of 77 records can be stored in one EEPROM. This can be increased to 154 records with the addition of a second EEPROM. These records are hard coded onto the EEPROM and will not be erased by cutting off the power supply or during a complete shutdown of the ELI, i.e. they will be kept in the EEPROM forever until they're overwritten by the 78th (or the 155th) events.

The three most recent records are displayed at one time on the view screen. The displayed records will move one record upward when the UP (↑) key is pressed, and move one record downward when the DOWN (↓) key is pressed.

Below is a list of the abnormal conditions that are stored and can be displayed:

HIGH DC SHUTDOWN / SHORT CIRCUIT! / FUSE/OVERHEAT / OVERLOAD SHUTDOWN / EMERGENCY STOP / INVERTER ABNORMAL / BYPASS ON SHUTDOWN

The display in the top right corner of the screen is the ELI installation time displayed in year/month. This information is provided to allow the user or the maintenance personnel to have a reference point to schedule the next preventative maintenance visit.
To return to MENU 1 press the ENTER (↵) key.

5.6. Menu 5 – Parameter Setting Menu

```
          PARAMETER SETTING
INVERTER=ON/OFF     DATE TIME
AUTO START=ON       TEST BATTERY
BOOST CHARGE                EXIT
```

Figure 5.12
Parameter Setting Menu Display

MENU 5 is reached by selecting PARAMETER SET on MENU 1 and access is only allowed if the correct password is entered (See figure 5.6.2). The cursor (→) is used to select which parameter the user would like to edit, such as INVERTER ON/OFF, AUTO START ON/OFF, BOOST CHARGE, DATE/TIME and TEST BATTERY. To select one of the different menu options move the cursor (→) until it is pointing at the correct selection, by press the UP (↑) key or the DOWN (↓) key. To confirm and select the menu option press the ENTER (↵) key.

The INVERTER ON/OFF option allows the user to activate or deactivate the inverter. When selected the blinking display (ON or OFF) indicates the current status of the inverter. To change the state of the inverter press the UP (↑) or the DOWN (↓) key and confirm selection by pressing the ENTER (↵) key. 'INVERTER = ON' will be displayed if 'ON' is selected or 'INVERTER = OFF' will be displayed if 'OFF' is selected.

The AUTO START ON option is set to ON as a factory default setting.

Selecting the 'EXIT' option (blinking instead of pointed by cursor) will return you to MENU 1.

```
PASSWORD: 1234
```

Figure 5.13
Password Menu Display

Boost Charge Menu

WARNING!
These settings have been preset by the factory to optimize the battery bank requirements. Do not change settings unless factory or factory trained service personnel have been consulted.

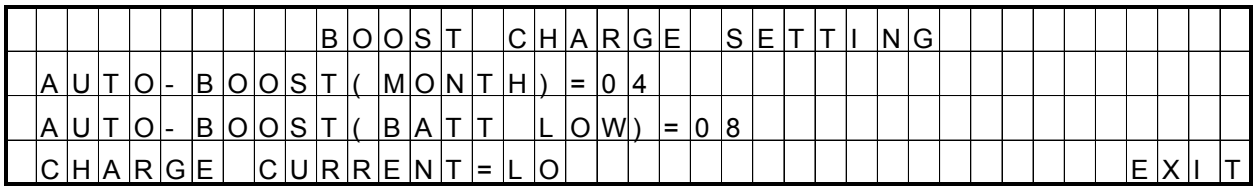


Figure 5.14
Boost Charge Setting Menu Display

This menu is reached by selecting BOOST CHARGE on MENU 5. This option allows the maintenance personnel to select the amount of boost charge required to maintain the batteries at their optimal performance.
Move the cursor (→) up or down (UP (↑) and DOWN (↓) key respectively) and select the option by pressing the ENTER (↵) key.

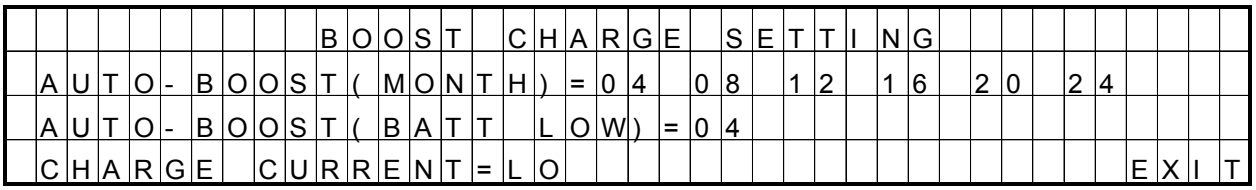


Figure 5.15
Boost Charge Setting Menu Display Program Settings

AUTO-BOOST (MONTH) controls the number of hours that the system will be boost charged every month. This boost charging conditions the batteries and increases the life expectancy of the batteries.

WARNING!
These are preset options by the factory. DO NOT CHANGE without consulting factory.

AUTO-BOOST (BATT LOW) controls the number of hours that the system will be boost charged after the system has reached a low battery condition. This boost charging recharges the batteries at a faster rate and will improve the conditioning of the batteries.

Both of the above AUTO-BOOST selections have six options for recharge rate (04, 08, 12, 16, 20 and 24) the numbers represent the number of hours the system will perform the boost charge for. The option is selected by the number of battery bank, the number of cells per battery bank and the type of batteries used within the battery bank. The factory set value will be display or will flash if the option has been selected. To select a different option use the UP (↑) or the DOWN (↓) key to select the time and press the ENTER (↵) key to confirm.

```
        BOOST CHARGE SETTING
AUTO-BOOST(MONTH) = 04
AUTO-BOOST(BATT LOW) = 04  08  12  16  20  24
CHARGE CURRENT = LO                       EXIT
```

Figure 5.16
Boost Charge Setting Menu Display Program Settings

CHARGE CURRENT increases the amount of charge current the rectifier/charge supplies the battery bank. There are three possible options (LO/ME/HI). The factory will set the system at the optimal charge level for the battery bank provided. To change the level of charge select the CHARGE CURRENT option then select the level of charge via the UP (↑) and DOWN (↓) keys. Once the level of charge has been selected confirm with the ENTER (↵) key.

The CHARGE CURRENT can be roughly selected by the simple rule listed below:

CHARGE CURRENT SETTING

10 – 30 min battery back-up	LOW
30 min – 1 hour battery back-up	MEDIUM
> 1 hour battery back-up	HIGH

Selecting the 'EXIT' option (blinking instead of pointed by cursor) will return you to MENU 5.

Date Time Setting Menu

```
        DATE TIME SETTING
YEAR =XXXX      HOUR(24H) =XX
MONTH=XX        MINUTE=XX
DAY=XX          DAY OF THE WEEK=MON   EXIT
```

Figure 5.17
Date Time Setting Menu Display

This menu is reached by selecting DATE/TIME on MENU 5. This menu allows the user to set the YEAR, MONTH, DAY, HOUR, MINUTE and DAY OF THE WEEK of the real time clock. The display upon selection is the current time and day (factory preset). To change any to the variables move the cursor (→) to the correct variable by pressing the UP (↑) and DOWN (↓) key, the ENTER (↵) key will confirm the selection.

Below is a list of the available variables:

- YEAR : 1998 – 2097
- MONTH : 01-12
- DAY : 01 – 31(internal calendar will correct it if 31 is entered to a 30day month)
- HOUR : 0 – 23
- MINUTE : 0 - 59
- DAY OF THE WEEK : MON, TUE, WED, THU, FRI, SAT, SUN

The values (selected value is flashing) are increased by the UP (↑) key, and can be decreased by the DOWN (↓) key and confirmed by the ENTER (↵) key.

If ‘EXIT’ is selected (blinking instead of pointed by cursor), the screen will go back to the MENU 5- the PARAMETER SETTING menu.

6. Physical Topology

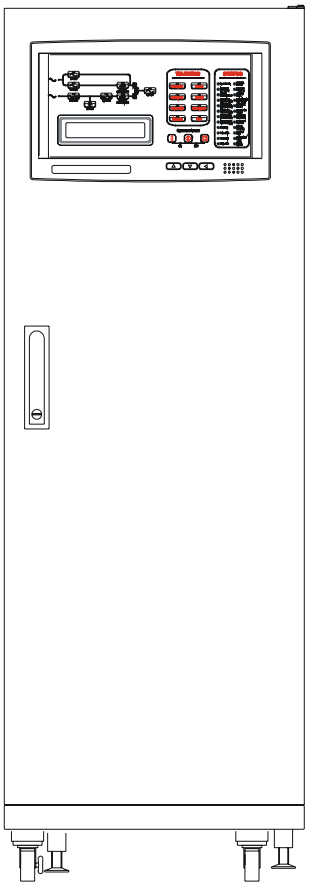


Figure 6.1
Front view of system with Door Closed

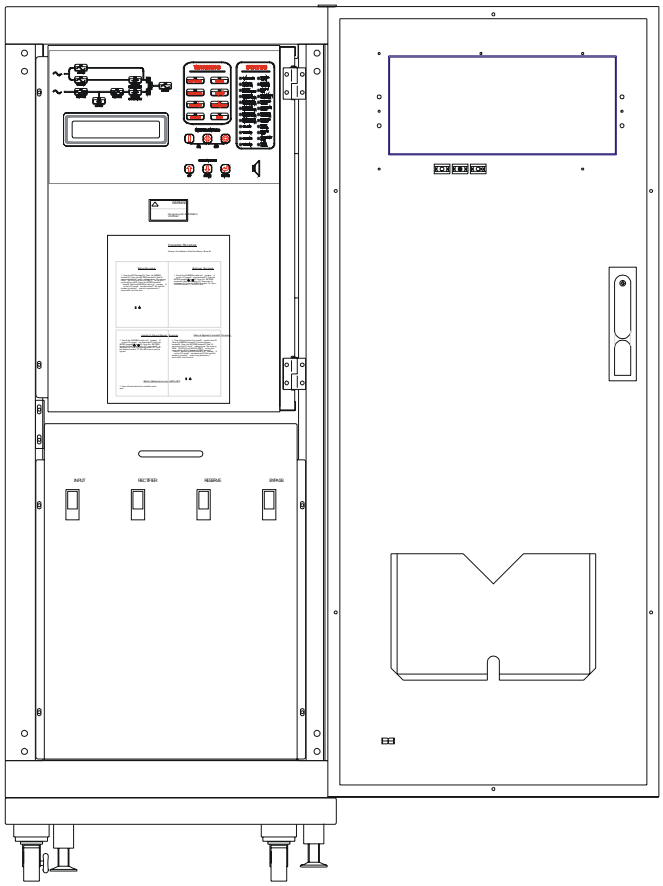


Figure 6.2
Front view of system with Door Open

ELI Rating	Dimensions			Weight	
(KW)	W (Width)	D (Depth)	H (Height)	ELI	Floor Loading
8	559mm (22")	815mm (32.0")	1,600mm (63.0")	380kg (838lbs)	864 kg/sq.m (177 lbs/sq.ft.)
12	559mm (22")	815mm (32.0")	1,600mm (63.0")	415kg (915lbs)	943 kg/sq.m (193 lbs/sq.ft)
16	559mm (22")	815mm (32.0")	1,600mm (63.0")	450kg (992lbs)	1,023 kg/sq.m (210 lbs/sq.ft)
24	559mm (22")	815mm (32.0")	1,600mm (63.0")	580kg (1,279lbs)	1,318 kg/sq.m (270 lbs/sq.ft.)
32	559mm (22")	815mm (32.0")	1,600mm (63.0")	650kg (1,433lbs)	1,477 kg/sq.m (303 lbs/sq.ft.)
40	559mm (22")	815mm (32.0")	1,600mm (63.0")	710kg (1,565lbs)	1,614 kg/sq.m (330 lbs/sq.ft)
48	1,100mm (43.25")	815mm (32.0")	1,600mm (63.0")	920kg (2,024lbs)	1,672 kg/sq.m (207 lbs.sq.ft.)

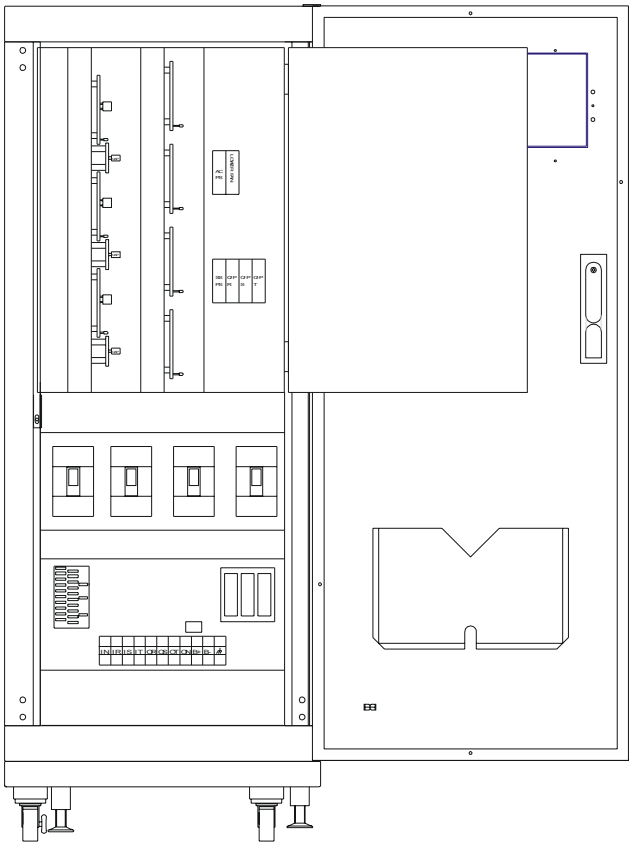


Figure 6.3
Front view of system with Door Open, PCB Module fully open and terminal strip cover off

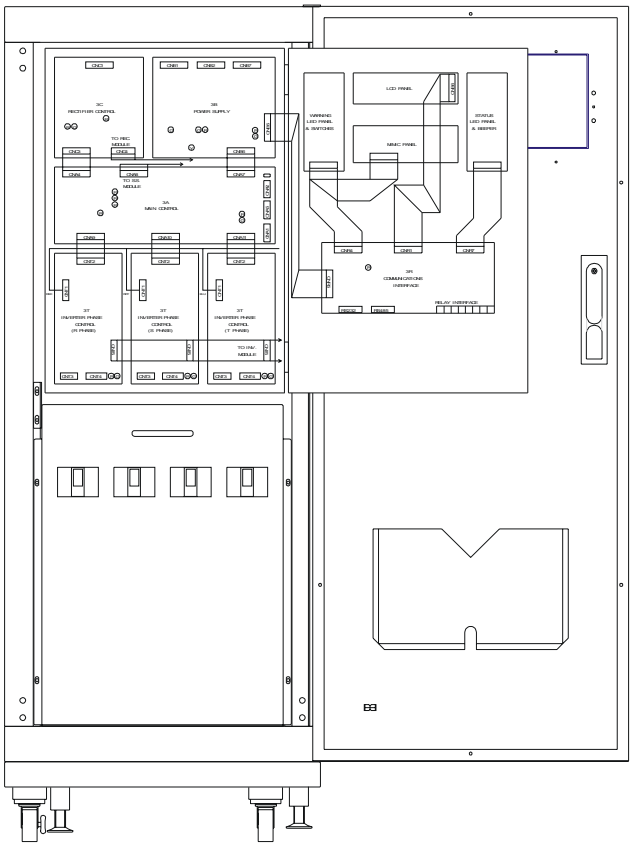


Figure 6.4
Front view of system with Door Open and PCB Module door open

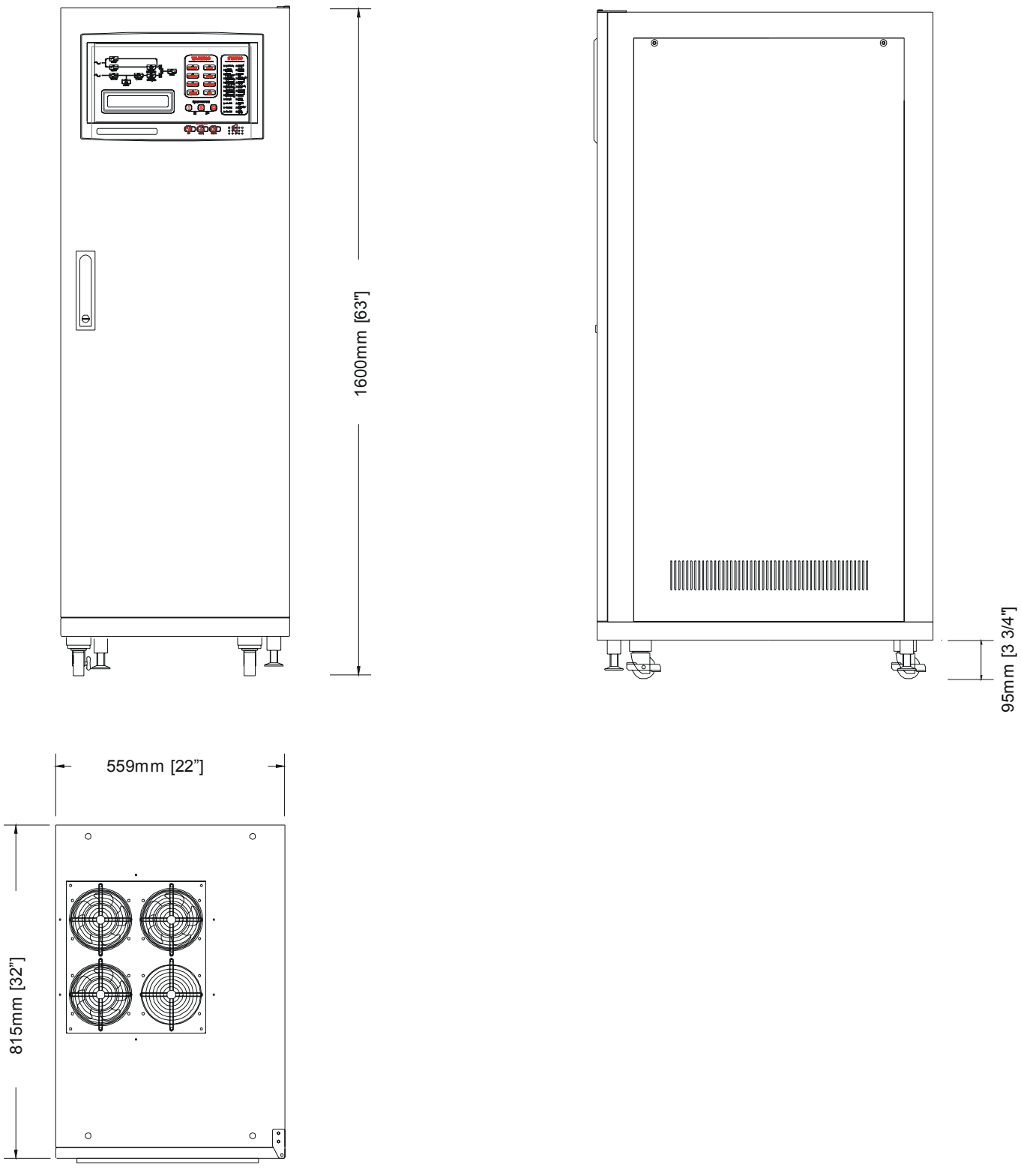


Figure 6.5
Front, Side & Top Views

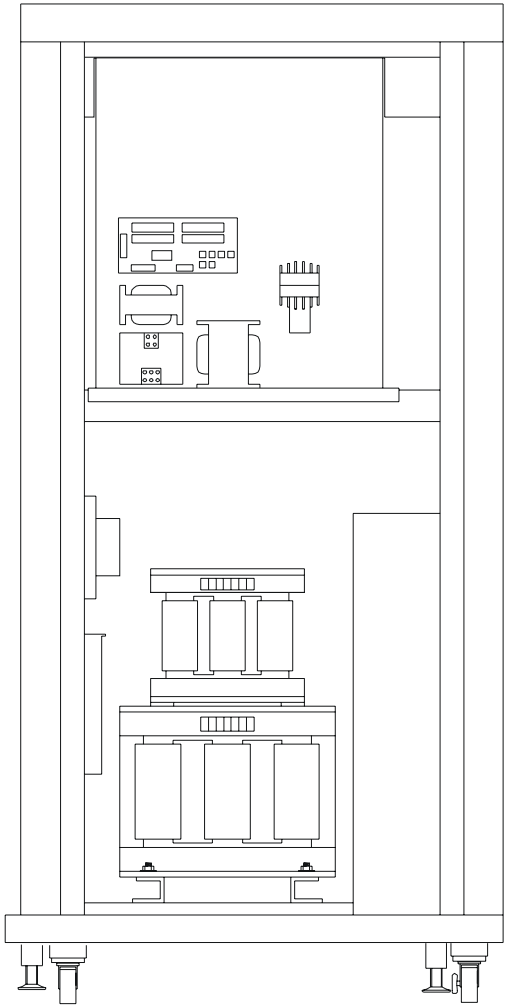


Figure 6.6
Layout view of the left side of the system with the panel off

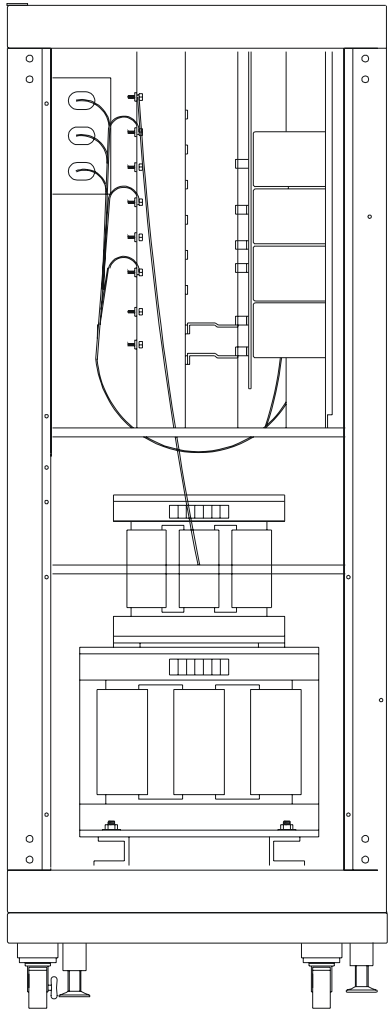


Figure 6.7
Layout view of the back of the system with the panel off

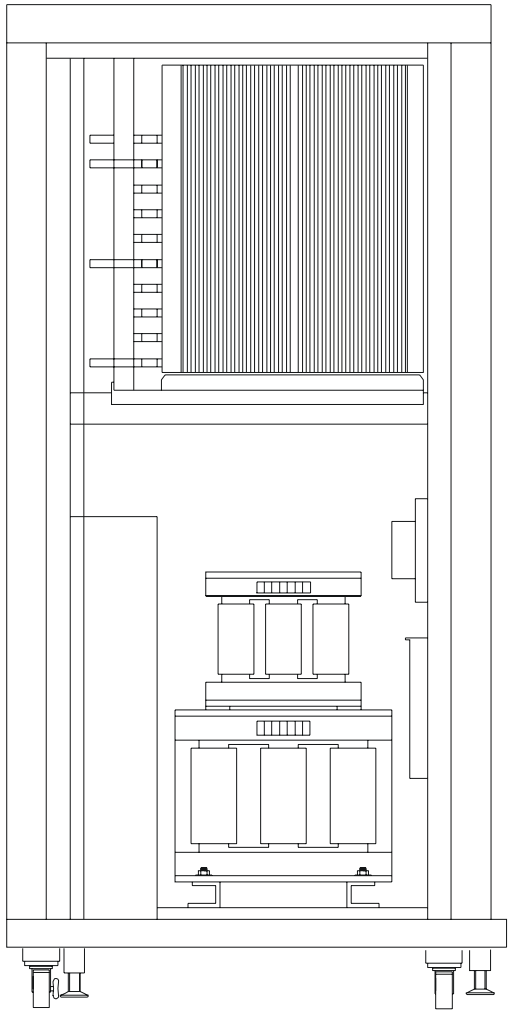


Figure 6.8
Layout view of the right side of the system with the panel off

7. Electrical Layout Drawings

7.1. Single Line Drawing

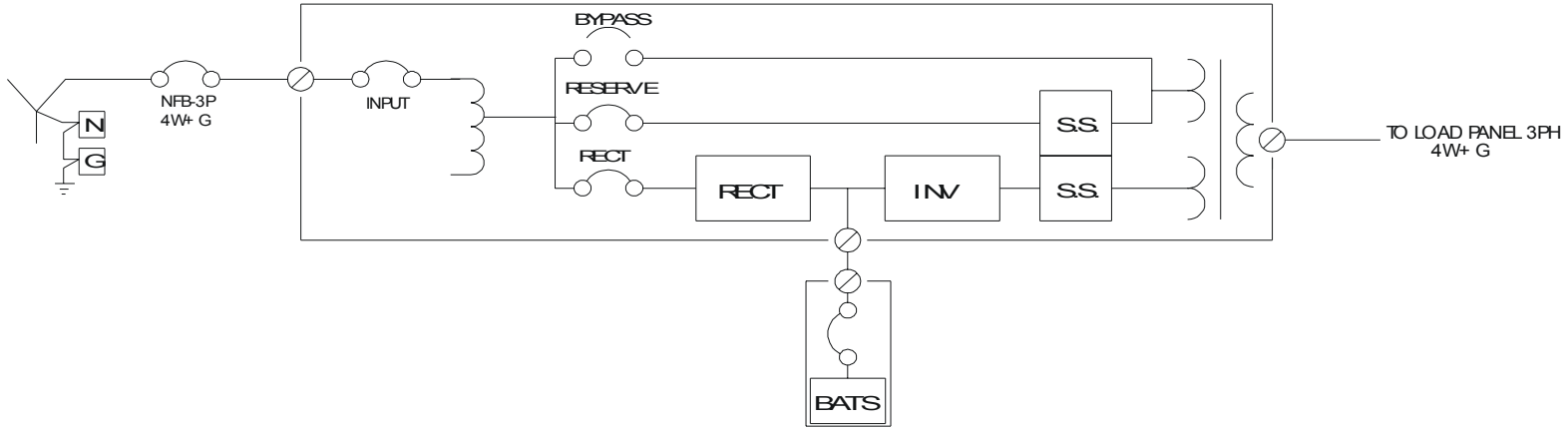


Figure 7.1
Single line Drawing

7.2. Topology Drawings

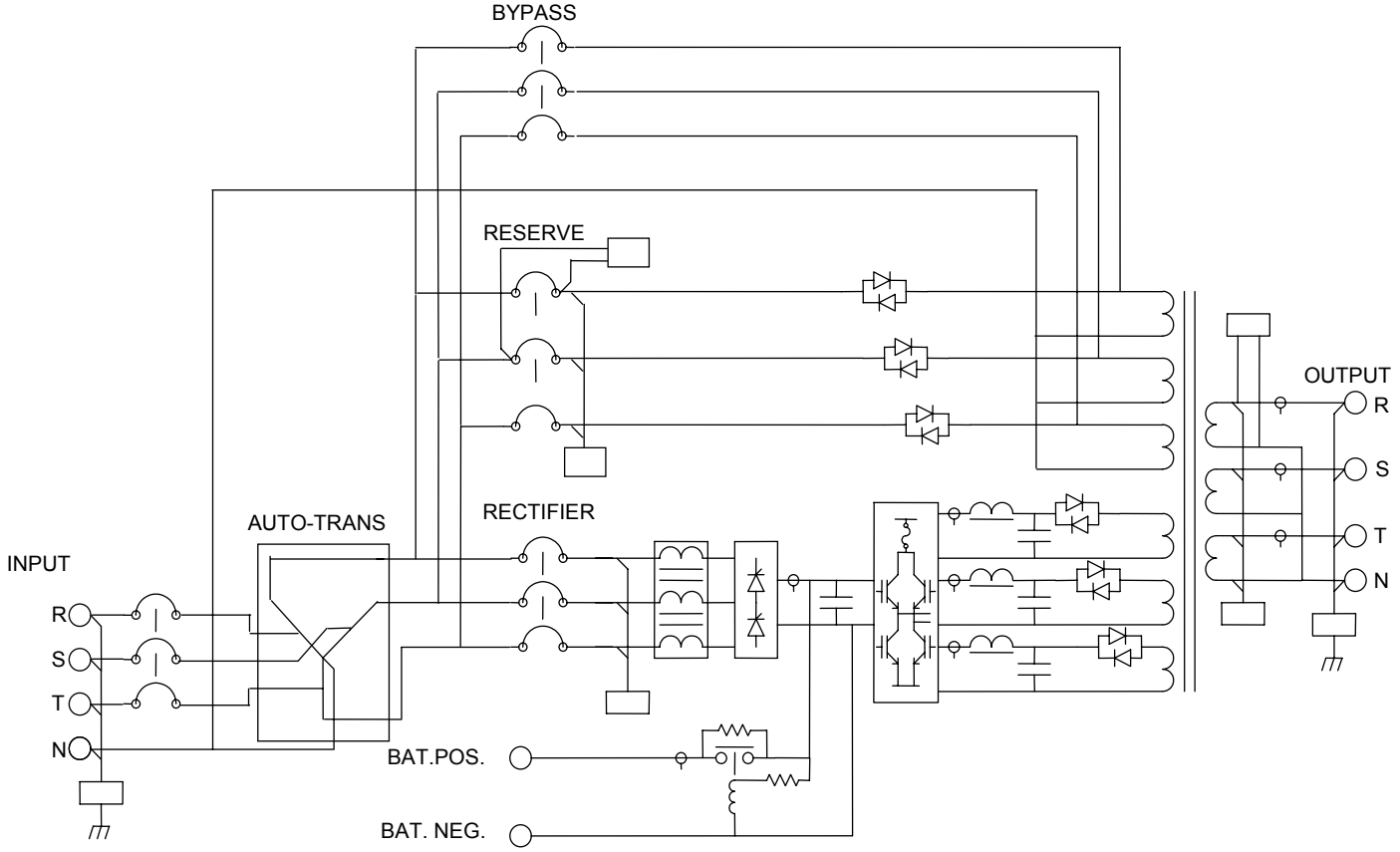


Figure 7.2
3 Phase ELI – 6 Pulse Rectifier

Always On
Topology - 3 Phase ELI 6 Pulse Rectifier
Input: 3PH-4W Output: 3PH-4W
Zero Degrees Phase Shift

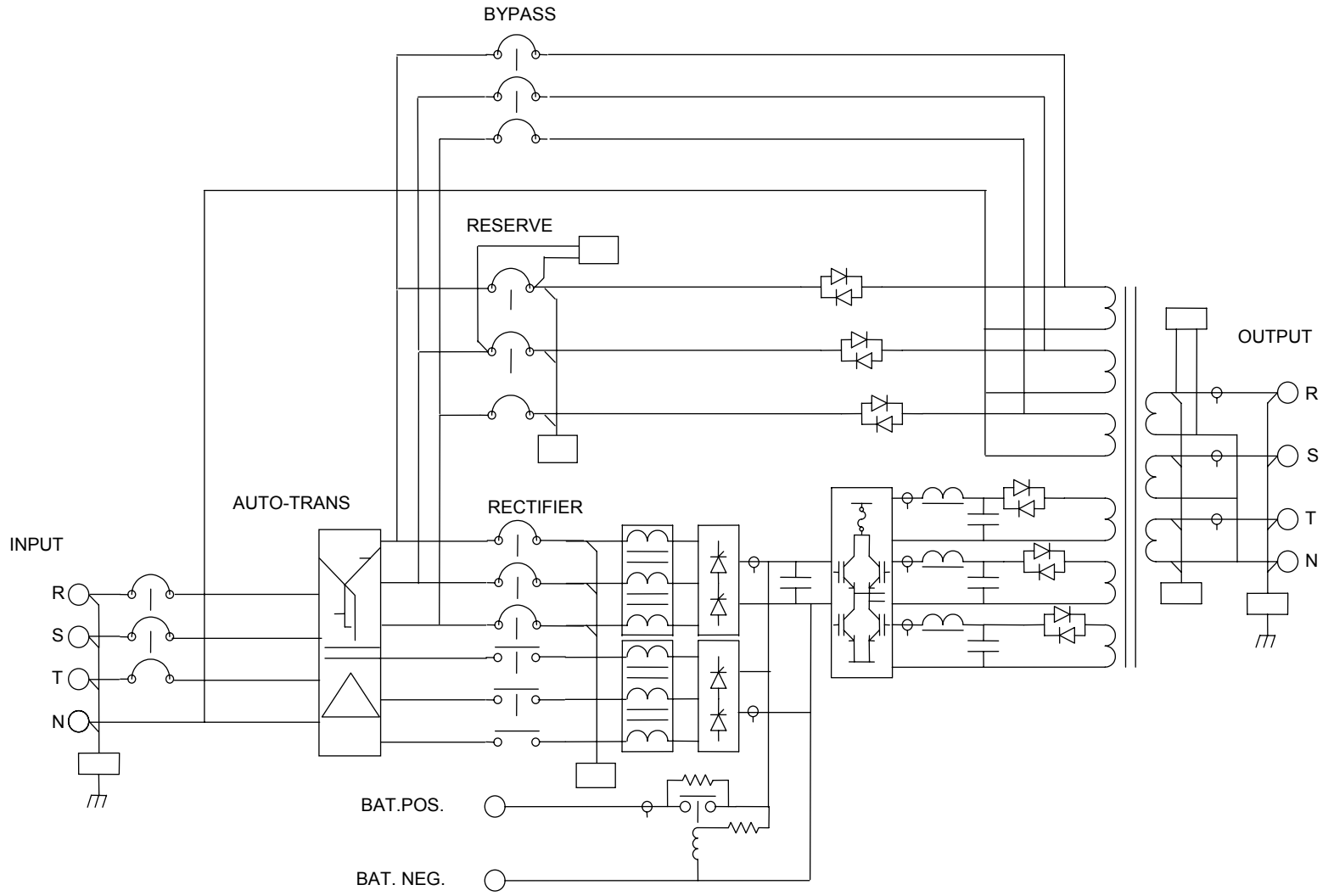


Figure 7.3
3 Phase ELI – 12 Pulse Rectifier

Always On
Topology - 3 Phase ELI 12 Pulse Rectifier
Input: 3PH-4W Output: 3PH-4W
Zero Degrees Phase Shift

7.3. Inter-PCB Diagram

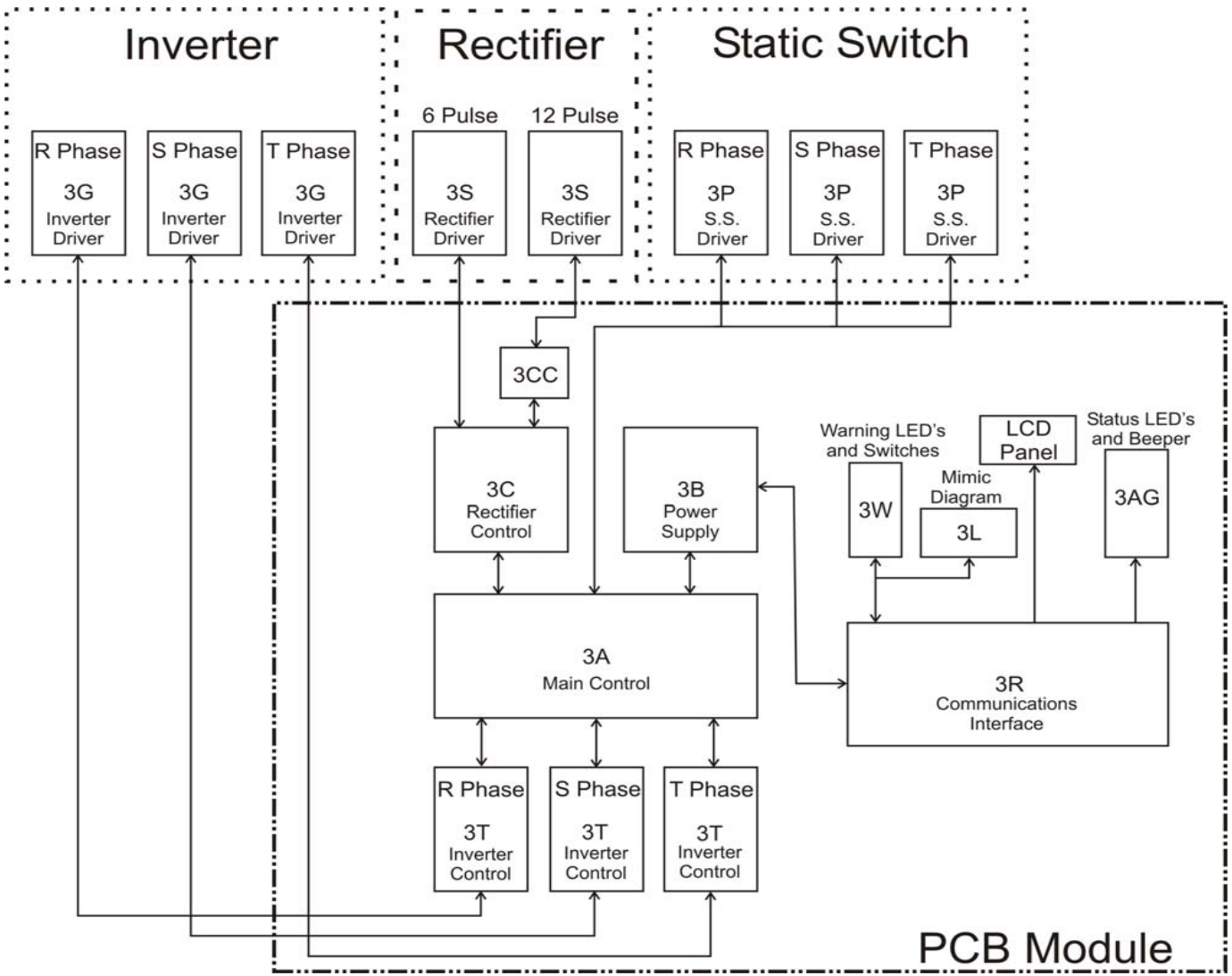


Figure 7.4
Connection diagram for the PCB Module, Inverter, Rectifier and Static Switch

7.4. PCB Module

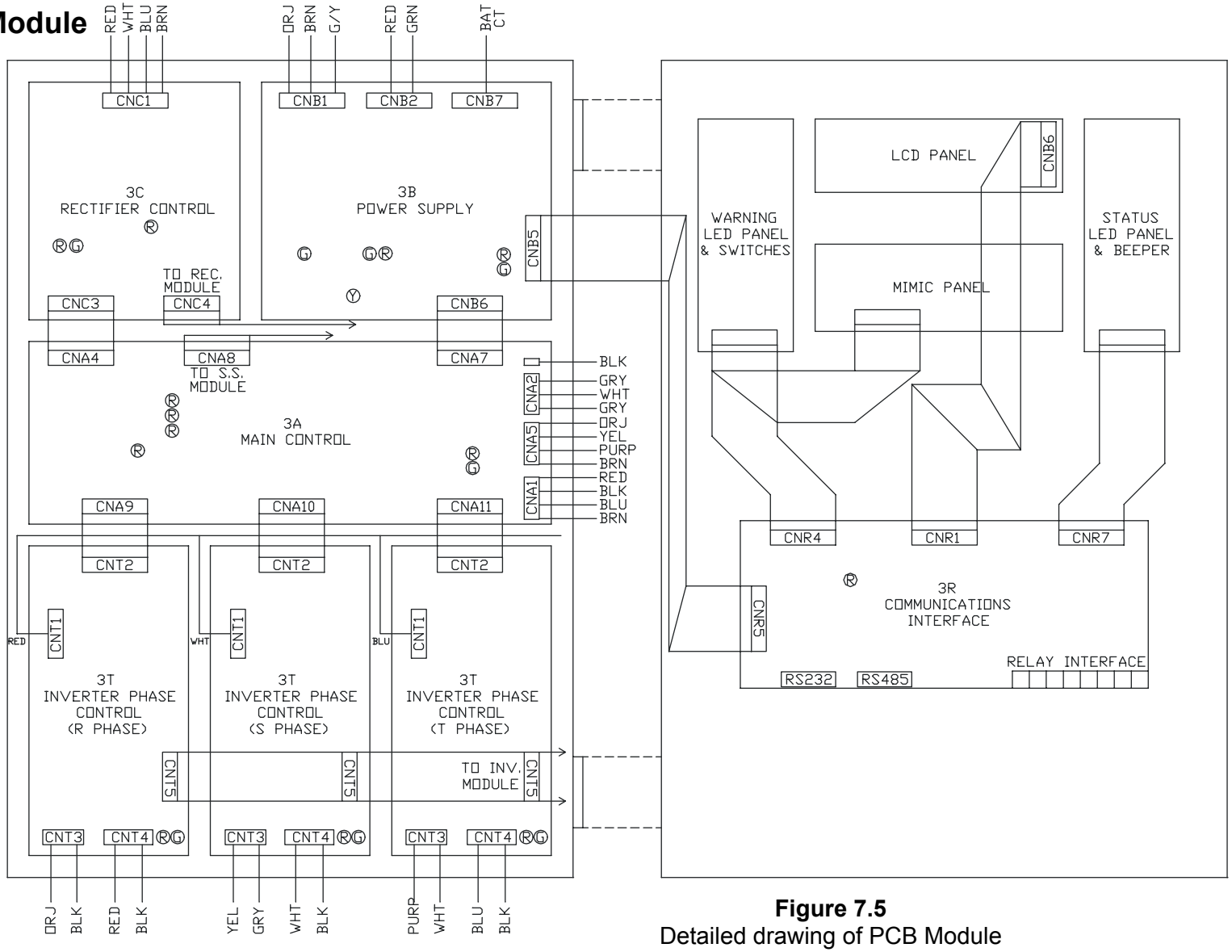


Figure 7.5
Detailed drawing of PCB Module

7.5. Rectifier

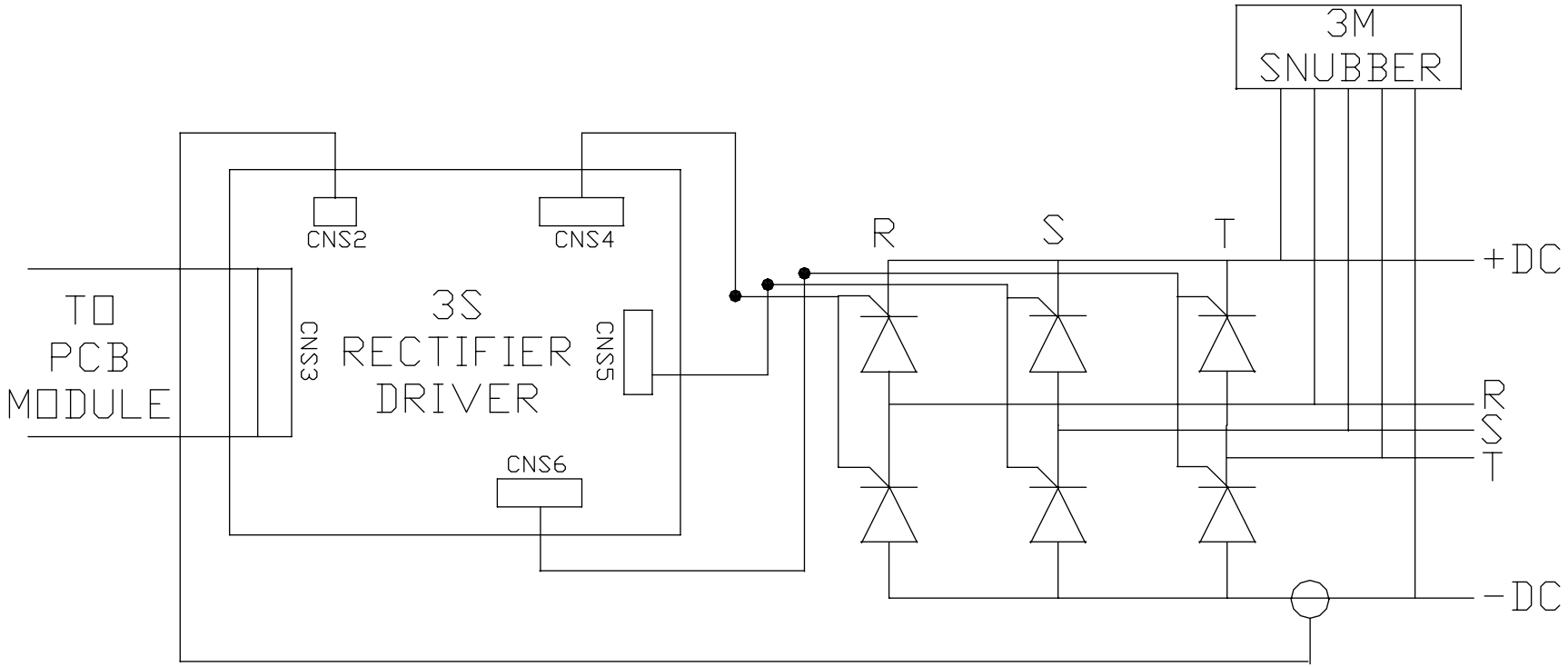


Figure 7.6
Detailed drawing of Rectifier System

7.6. Inverter

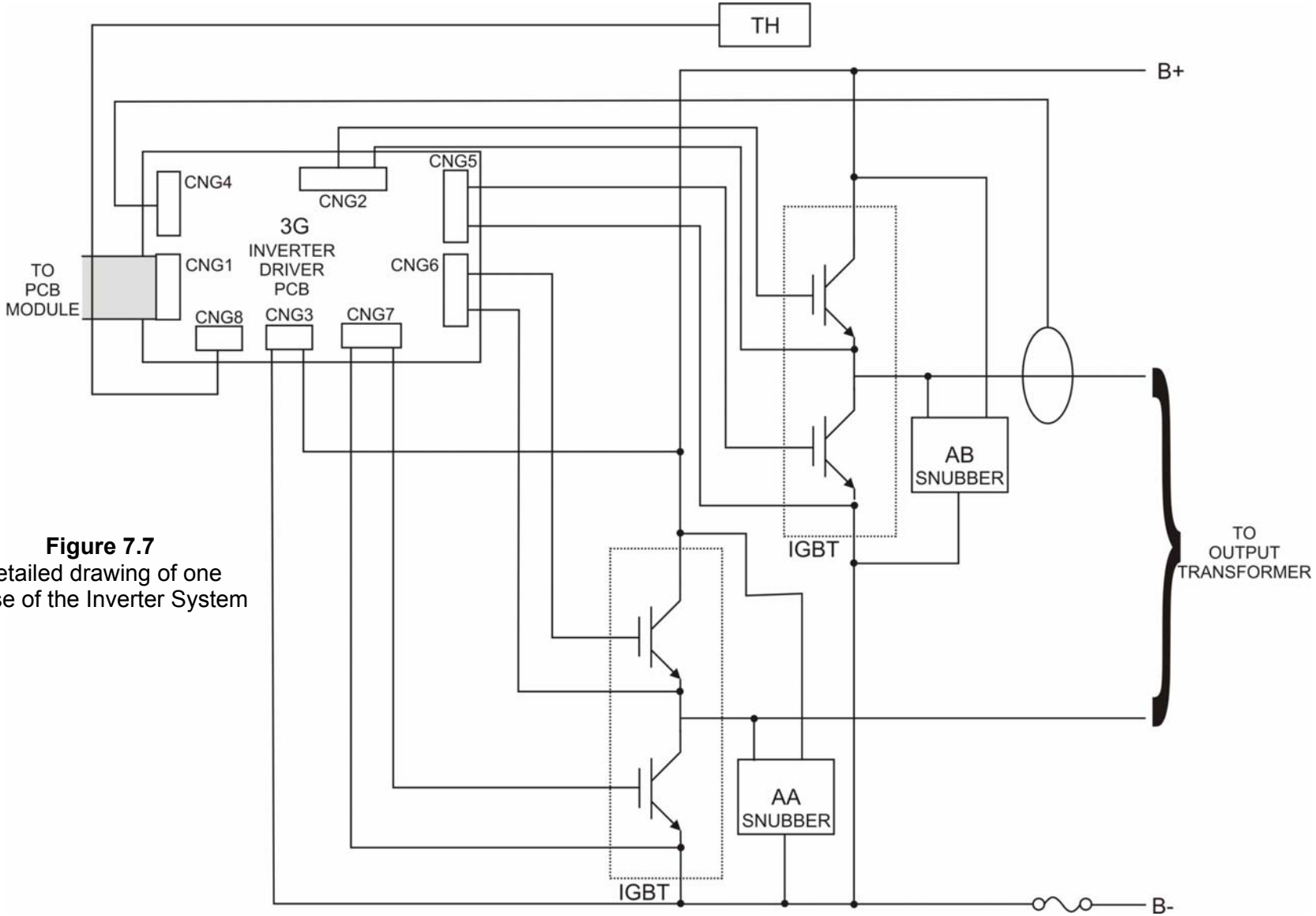


Figure 7.7
Detailed drawing of one phase of the Inverter System

7.7. Static Switch

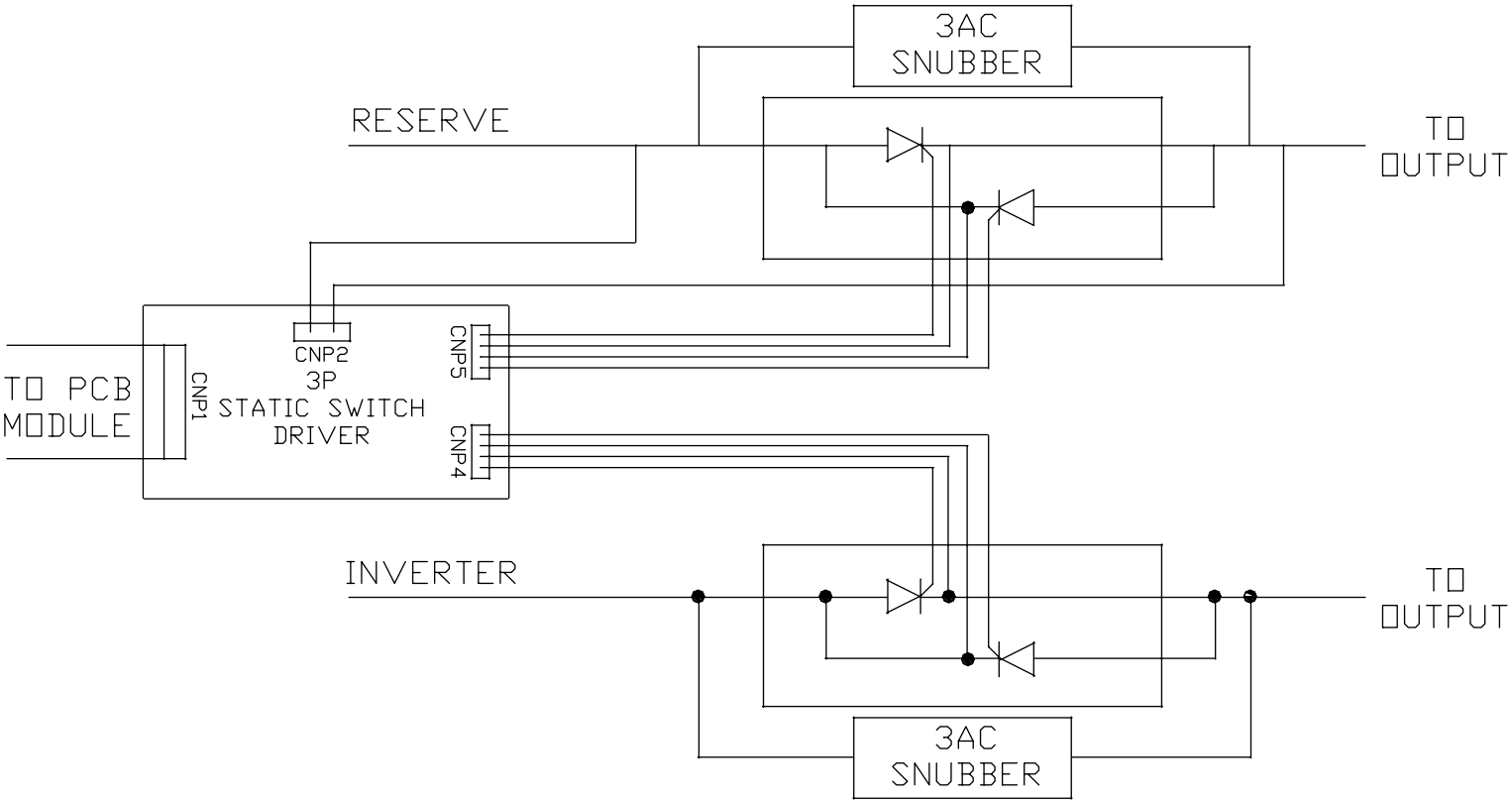


Figure 7.8
Detailed drawing of one phase of the
Static Switch System

7.8. Auxiliary Power Supply

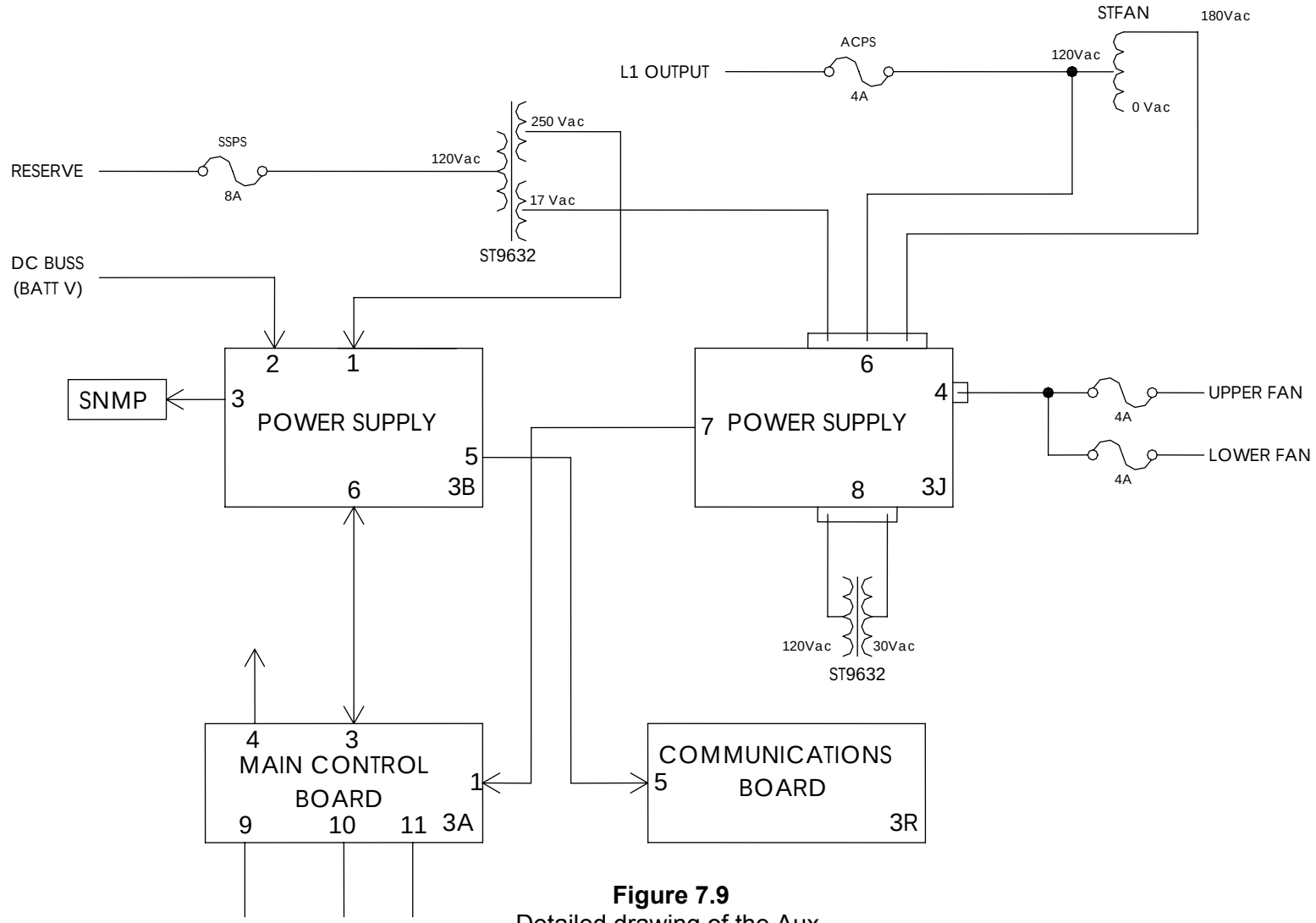


Figure 7.9
Detailed drawing of the Aux.
Power Supply

8. Troubleshooting

8.1. Main Control (3A PCB)

The Main Control PCB monitors and controls all the major components within the ELI system. Through the various monitoring devices and PCB's (mentioned later in this manual) it provides all the control signals, synchronizing signals and various conditions to the ELI system and Operator interfaces.

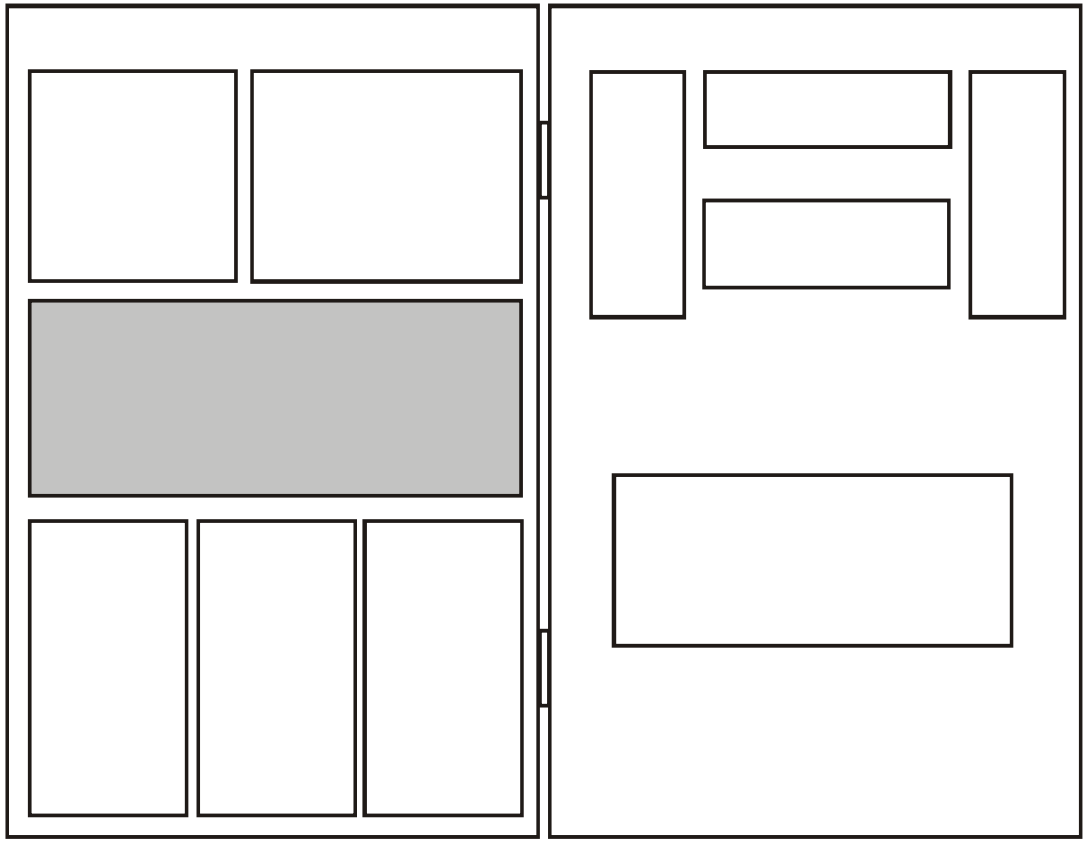


Figure 8.1
Location of 3A PCB in the PCB Module

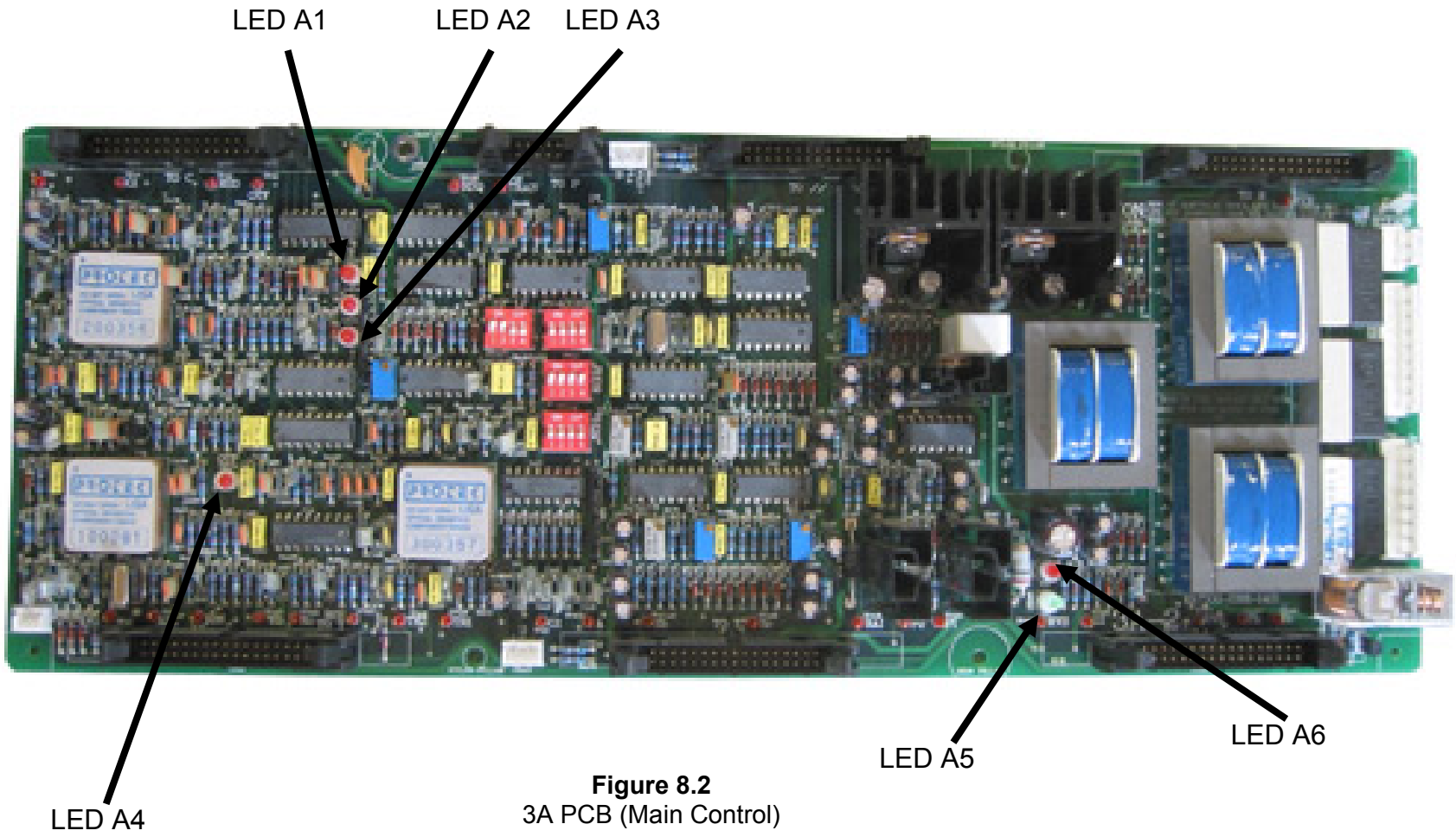


Figure 8.2
3A PCB (Main Control)

Table 8.1 LED Operation for the 3A PCB

PCB	FUNCTION	LOCATION	NORMAL			ABNORMAL		SOLUTION
			PCB LED	LED Illuminated	Description	LED Illuminated	Description	
3A	Main Control	PCB Module	LED A1	No	3T (R phase working)	Yes	R phase failure and ELI shutdown	Check 3T (R phase) ensure cable connections are secure and correctly attached.
								Replace the board
			LED A2	No	3S (S phase working)	Yes	S phase failure and ELI shutdown	Check 3T (S phase) ensuring cable connections are secure and correctly attached.
								Replace the board
			LED A3	No	3T (T phase working)	Yes	T phase failure and ELI shutdown	Check 3T (T phase) ensuring cable connections are secure and correctly attached.
								Replace the board
			LED A4	No	3G working	Yes	3G has problem	Check 3G and ensure cable connections are secure and correctly attached.
								Replace the board
			LED A5, A6	All Yes	PCB has power	All No	PCB has no input power	Check 3B and ensure cable connections are secure and correctly attached.
								Replace the board

8.2. Power Supply (3B PCB)

This is the main power supply for the PCB and is the interface between the Main Control PCB and the Battery supply.

It provides battery condition information to the Main Control PCB to control the Rectifier/Charger. It also provides visual indication of the charging mode.

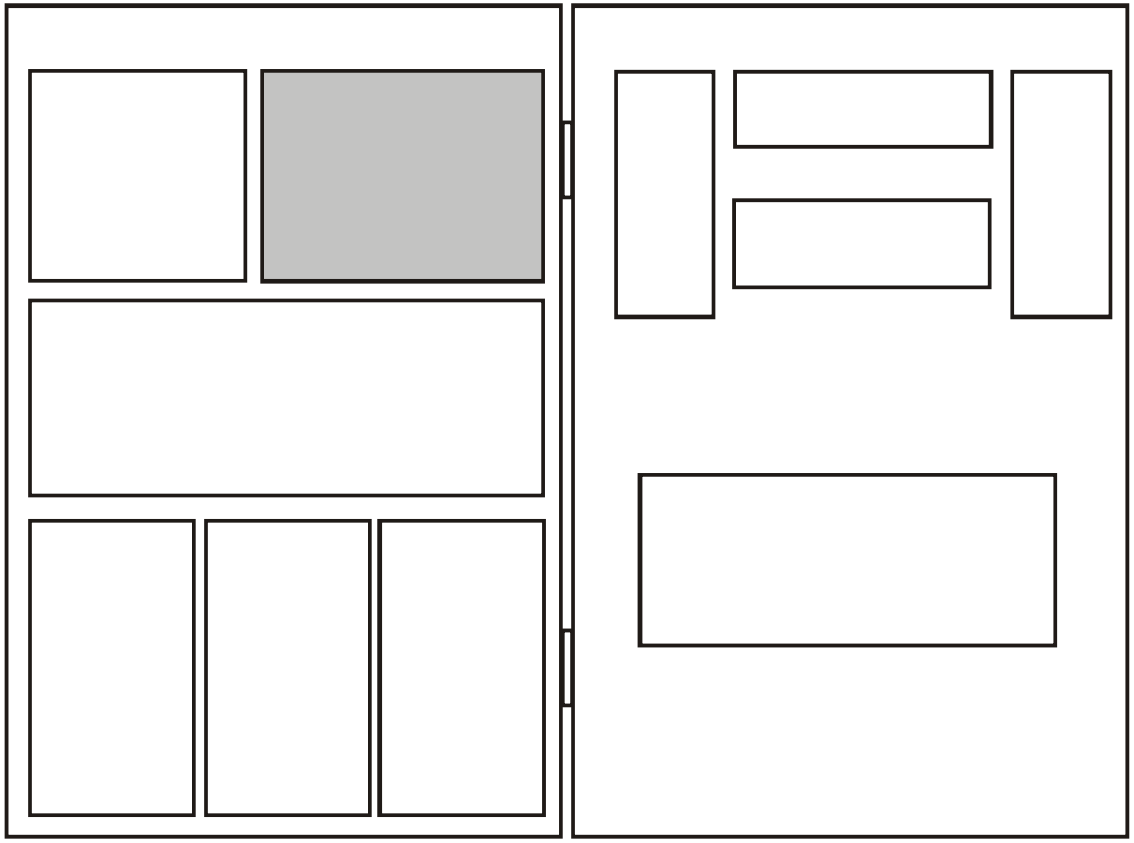


Figure 8.3
Location of 3B PCB in the PCB Module

Figure 8.4
3B PCB (Power Supply)

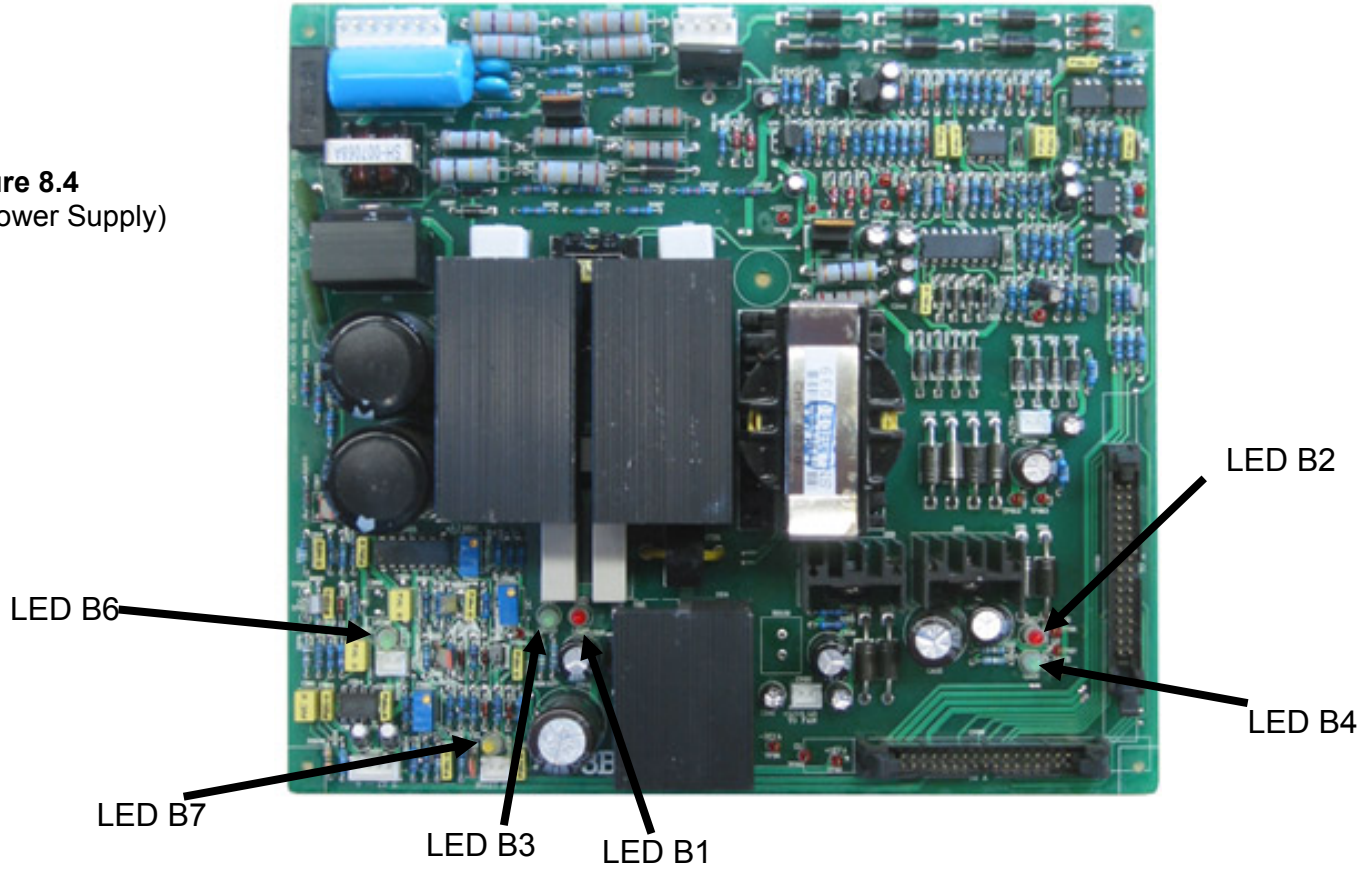


Table 8.2 LED Operation for the 3B PCB

PCB	FUNCTION	LOCATION	NORMAL			ABNORMAL		SOLUTION
			PCB LED	LED Illuminated	Description	LED Illuminated	Description	
3B	Power Supply	PCB Module	LED B1, B2, B3, B4	All Yes	PCB has power	All No	All LED's of PCB extinguished	Check fuse set behind PCB holder and ensure cable connections are secure and correctly attached. Replace the board
			LED B6	Yes	The system is testing the batteries			
			LED B7	Yes	The system is boost charging the batteries.			

8.3. Rectifier Control Circuit (3C PCB)

This PCB acts as the interface between the Main Control PCB and the Rectifier Module.

It relays the control signals from the Main Control PCB to the Rectifier Driver (3S PCB) within the Rectifier Module.

It also monitors all aspects of the Rectifier Module. This information is then forwarded to the Main Control PCB as part of the control loop.

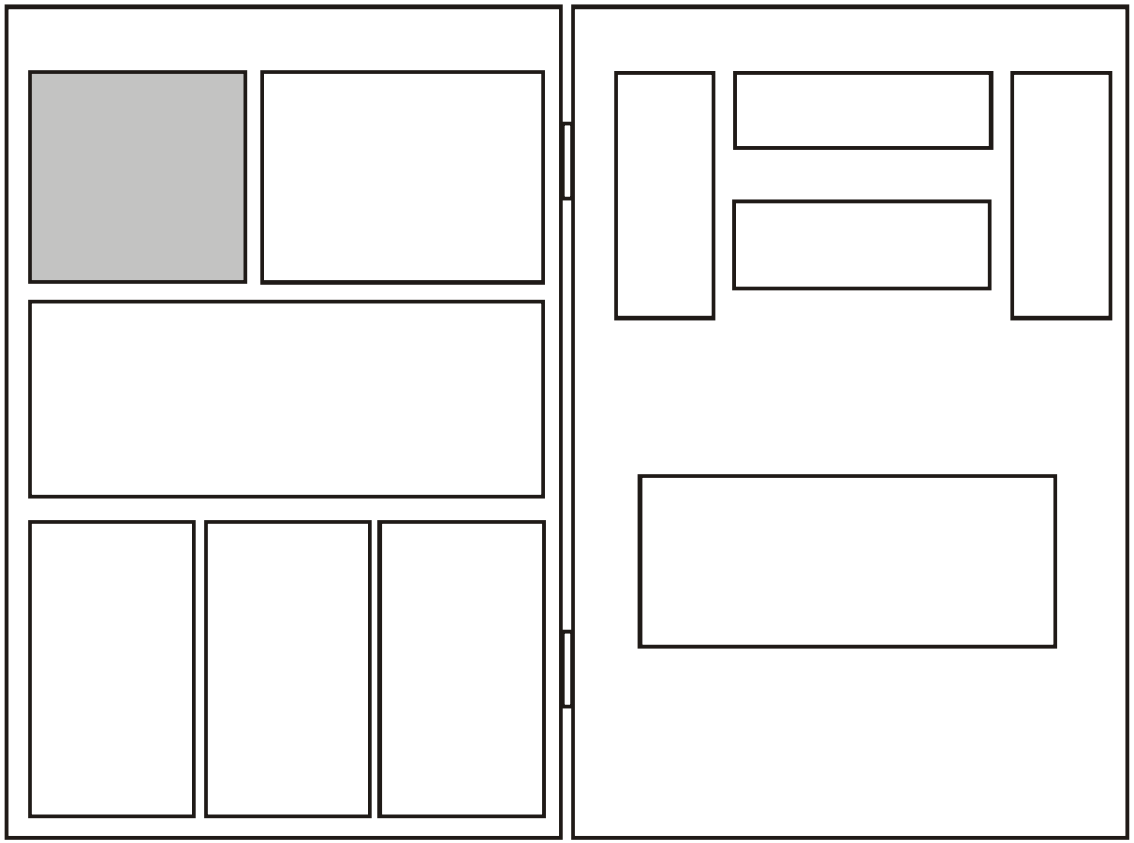


Figure 8.5
Location of 3C PCB in the PCB Module

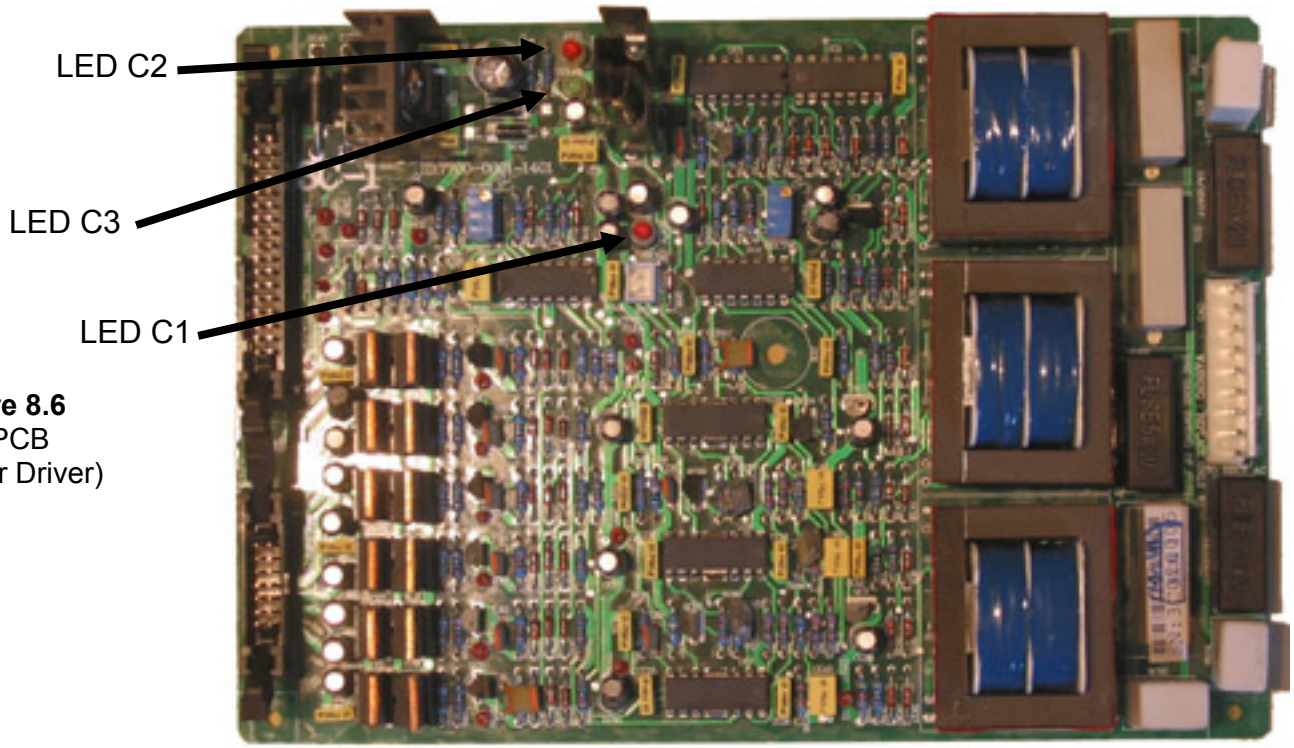


Figure 8.6
3C PCB
(Rectifier Driver)

Table 8.3 LED Operation for the 3C PCB

PCB	FUNCTION	LOCATION	NORMAL			ABNORMAL		SOLUTION
			PCB LED	LED Illumination	Description	LED Illumination	Description	
3C	Rectifier Control (It is separated into 3CC and 3CD board for the option of 12 pulse)	PCB Module	LED C1	Yes	Rectifier Enabled	No	PCB has no input power or input power outside of operating parameters	Ensure cable connections are secure and correctly attached.
								Check the input power
								Replace the board
			LED C2, C3	All Yes	PCB has power	All No	PCB has no input power	Ensure cable connections are secure and correctly attached.
								Replace the board

8.4. Inverter Phase Control (3T PCB)

This PCB acts as the interface between the Main Control PCB and each phase of the Inverter Module.

It relays the control signals and inverter drive waveforms from the Main Control PCB to the Inverter Driver (3G PCB) within each phase of the Inverter Module.

It also monitors all aspects of the Inverter Module. This information is then forwarded to the Main Control PCB as part of the control loop.

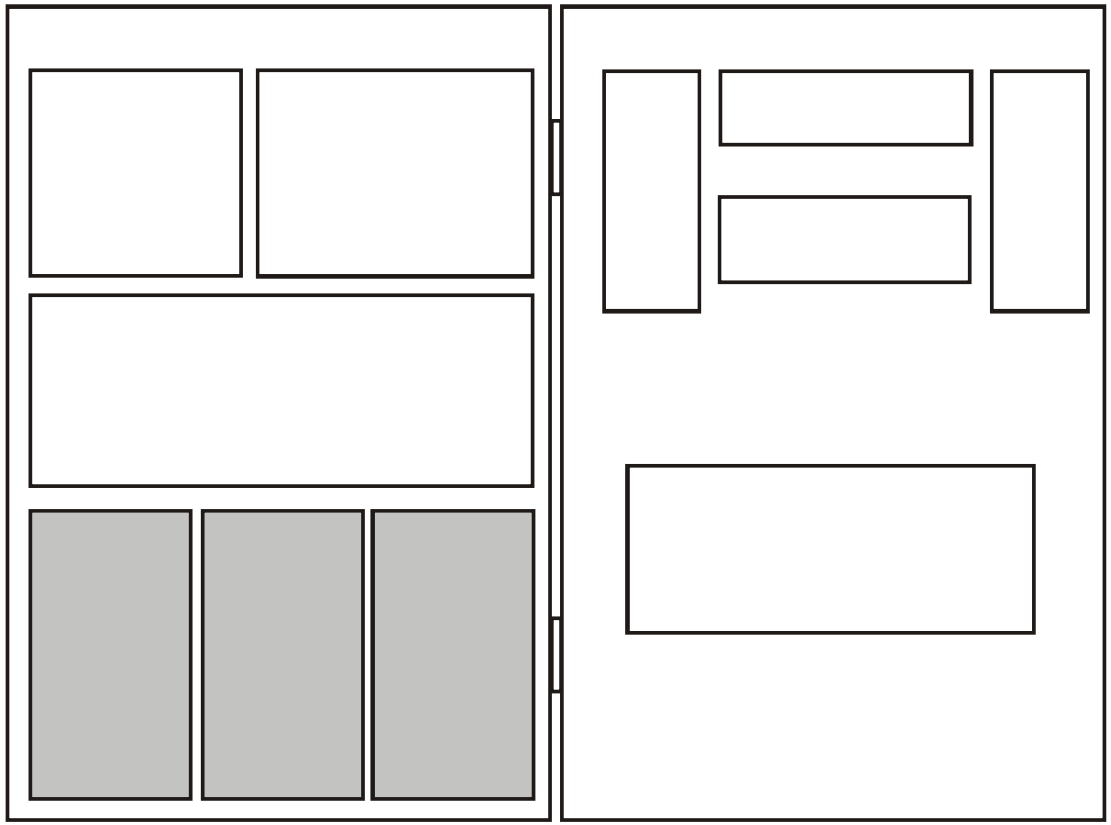


Figure 8.7
Location of 3T PCB in the PCB Module

Figure 8.8
3T PCB
(Inverter Driver)

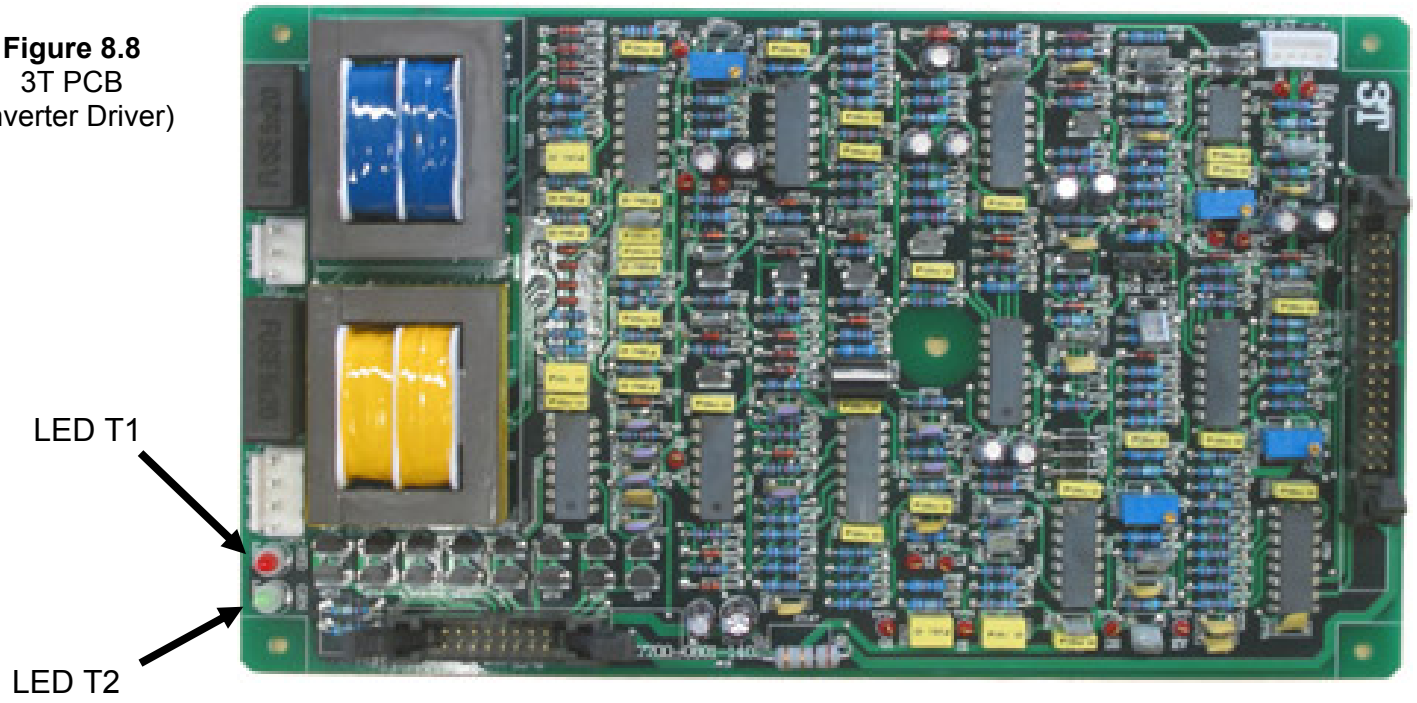


Table 8.4 LED Operation for the 3T PCB

PCB	FUNCTION	LOCATION	NORMAL			ABNORMAL		SOLUTION
			PCB LED	LED Illumination	Description	LED Illumination	Description	
3T	Inverter Phase Control	PCB Module	LED T1, T2	All Yes	PCB has power	All No	R, S or T phase lost, output LED on the front panel (mimic diagram) blinks indicating lost phase.	Ensure cable connections are secure and correctly attached. Replace the board

8.5. Communications Interface (3R PCB)

This is the local and remote Operator interface for the entire ELI system.

This controls the local front panel Operator interface by utilizing information from the Main Control PCB and translating and sending that to the front panel display PCB's. Also receives the local Operator commands from front panel display PCB's and relays these to the Main Control PCB.

It also provides remote communication links via multiple protocols for Operator monitoring and control.

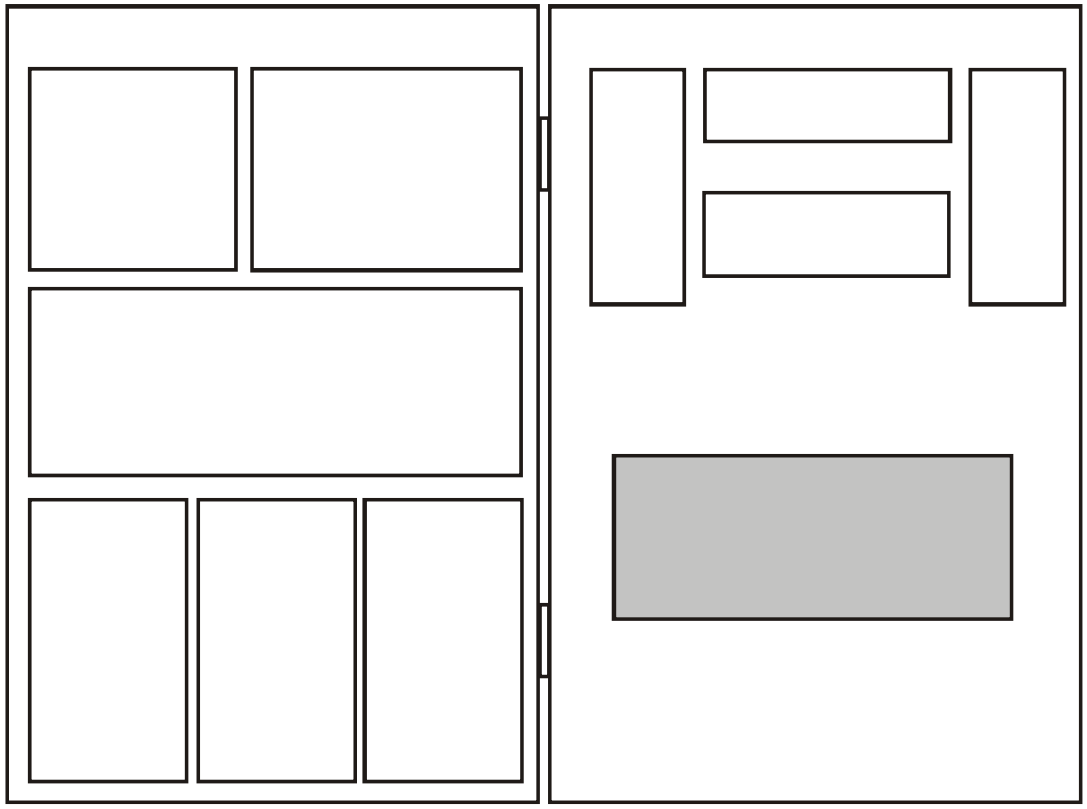


Figure 8.9
Location of 3R PCB in the PCB Module

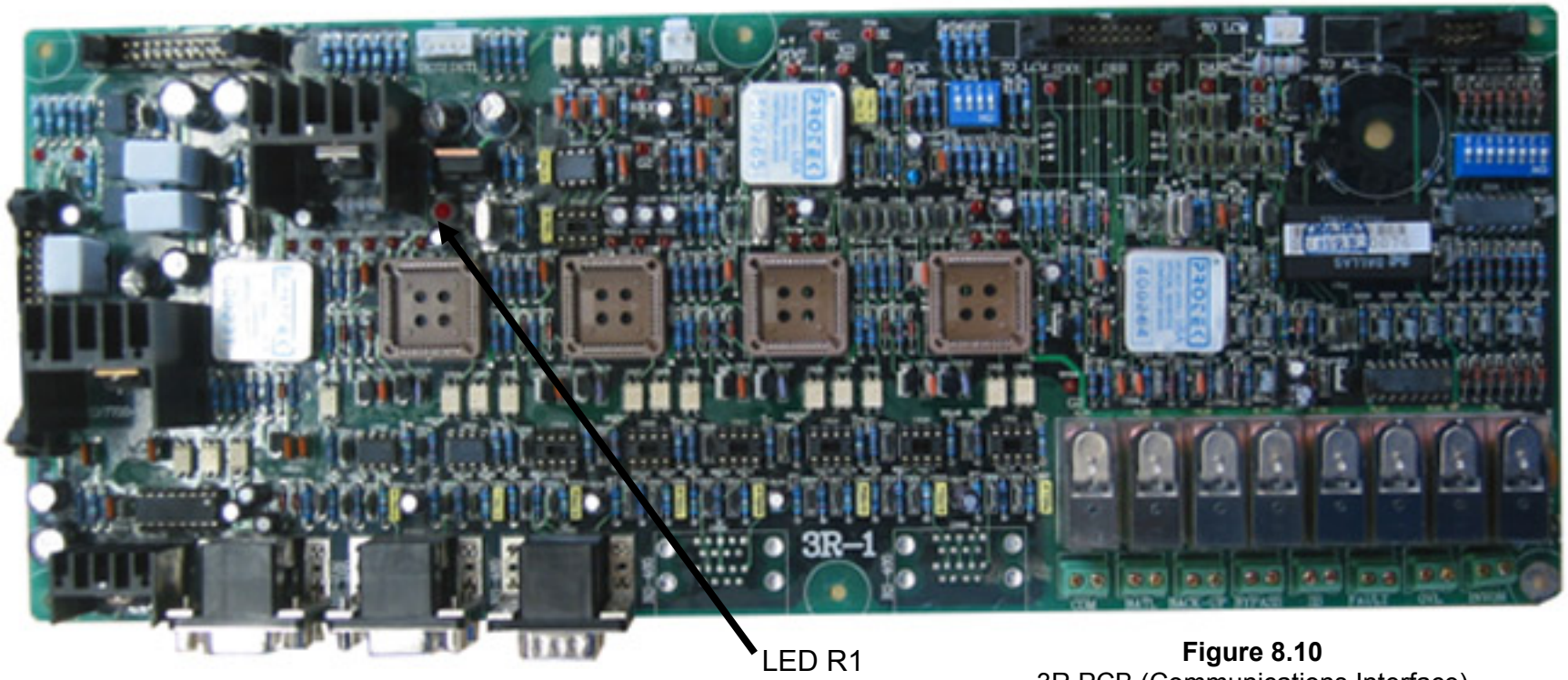


Figure 8.10
3R PCB (Communications Interface)

Table 8.5 LED Operation for the 3T PCB

PCB	FUNCTION	LOCATION	NORMAL			ABNORMAL		SOLUTION
			PCB LED	LED Illumination	Description	LED Illumination	Description	
3R	Communication Interface	PCB Module	LED R1	Yes	PCB has power	No	Interface communication failure	Ensure cable connections are secure and correctly attached.
								Replace the board

8.6. Warning LED's and Switches (3W PCB)

8.7. LCD Display

8.8. Mimic Diagram (3L PCB)

8.9. Status LED's and Audible Alarm (3AG PCB)

These PCB's make up the local Operator display and control interface.

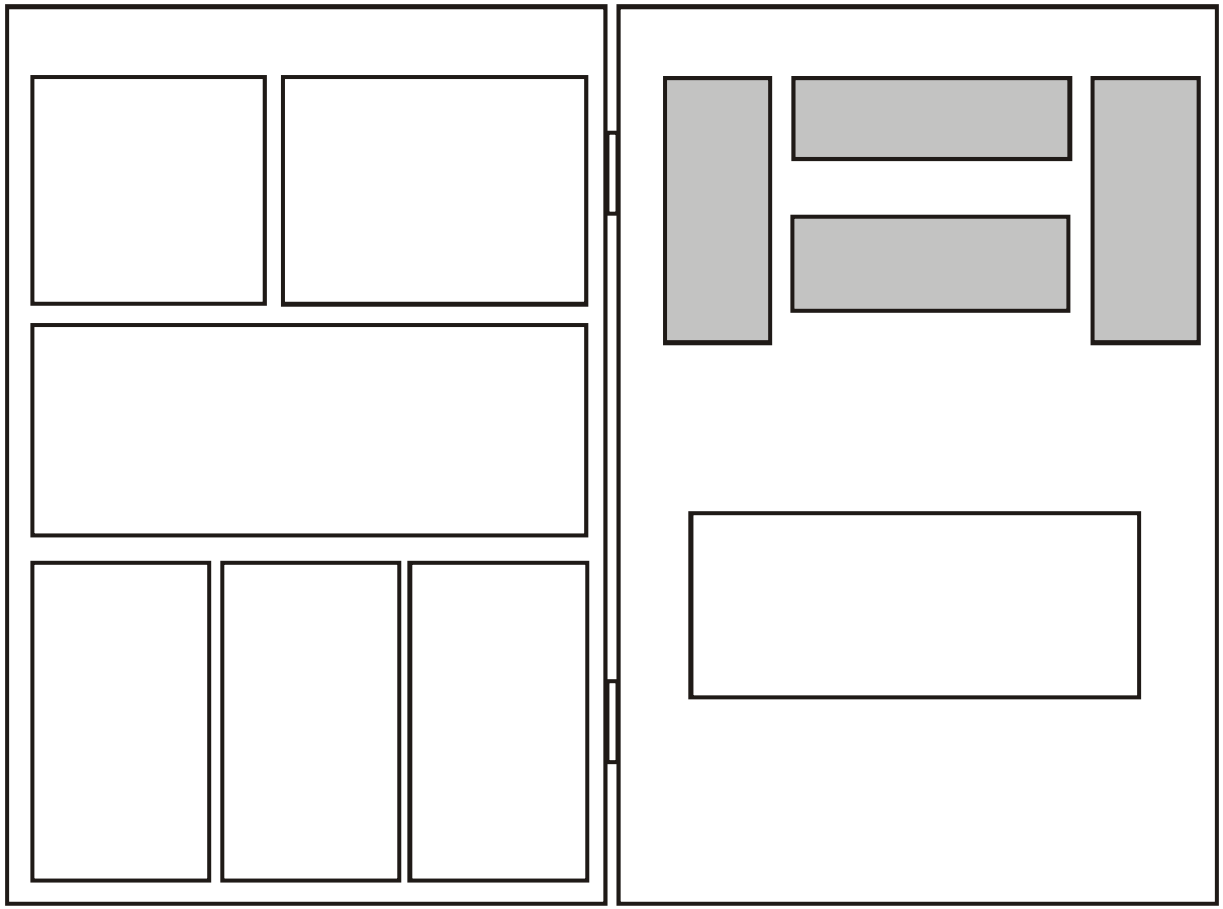


Figure 8.11
Location of Display PCB's in the PCB Module

8.10. Inverter Module

This is a Pluggable Module, which contains the high power devices for the inverter. The inverter converts the power from the DC Bus to regulated and conditioned AC power.

One phase of the inverter is comprised of an Inverter Driver PCB (3G PCB), high powered IGBT's, a Protection Fuse and other monitoring and protecting components.

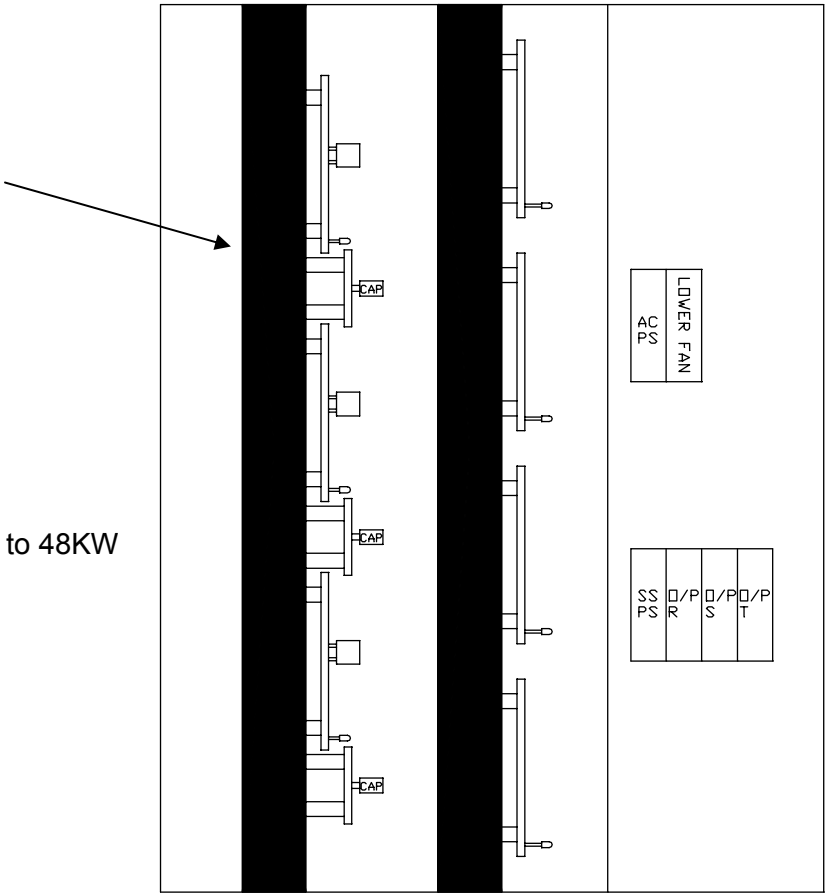


Figure 8.12
Location of Inverter Modules in the 8 to 48KW ELI system

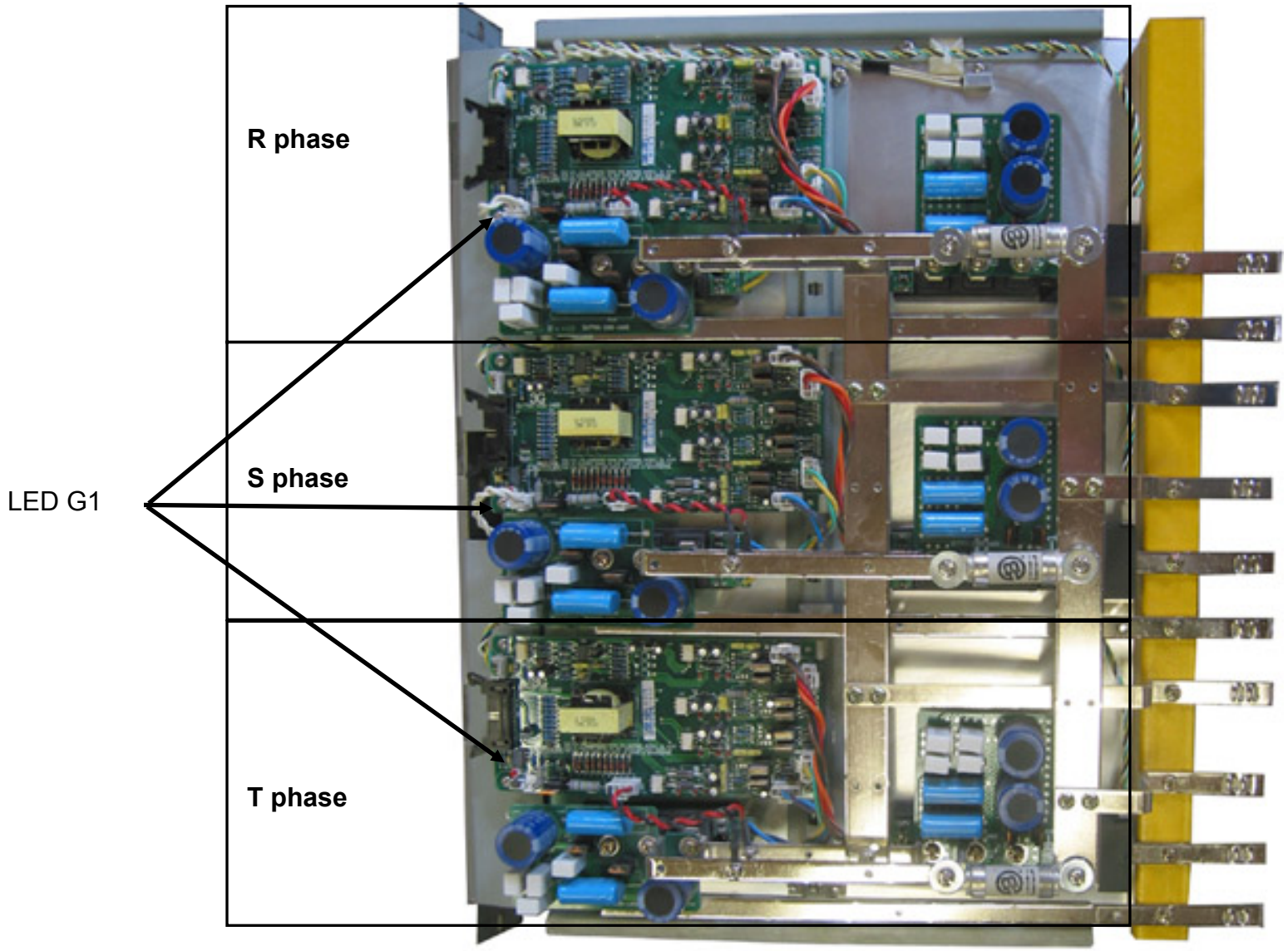


Figure 8.13
Picture of the Inverter Module from a 8 to 48KW ELI system

Table 8.6 LED Operation for the 3G PCB

PCB	FUNCTION	LOCATION	NORMAL			ABNORMAL		SOLUTION
			PCB LED	LED Illumination	Description	LED Illumination	Description	
3G	Inverter Driver (RST)	Inverter Module	LED G1	Yes	Inverter working	No	Inverter failure	Ensure cable connections are secure and correctly attached. Replace the board

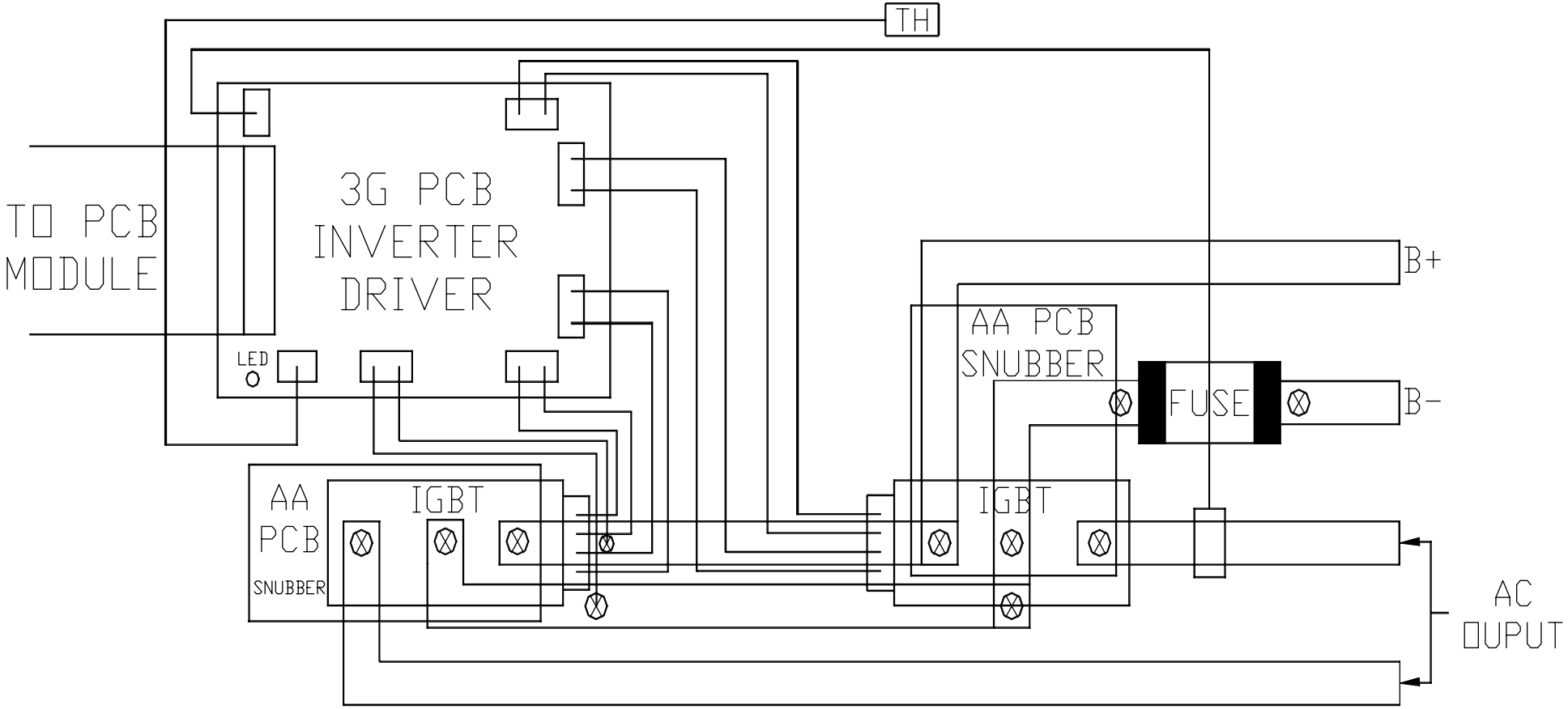


Figure 8.14
Layout of one phase of the Inverter Module

8.11. Rectifier Module

This is a Pluggable Module, which contains the high power devices for the rectifier/charger. The rectifier converts the power from the AC utility to regulated and conditioned DC power, which is used to charge the batteries and supply the DC Bus.

The rectifier can be configured as a 6 pulse or 12 pulse rectifier system. The rectifier is comprised of a Rectifier Driver (3S PCB), high powered SCR's and other monitoring and protection components.

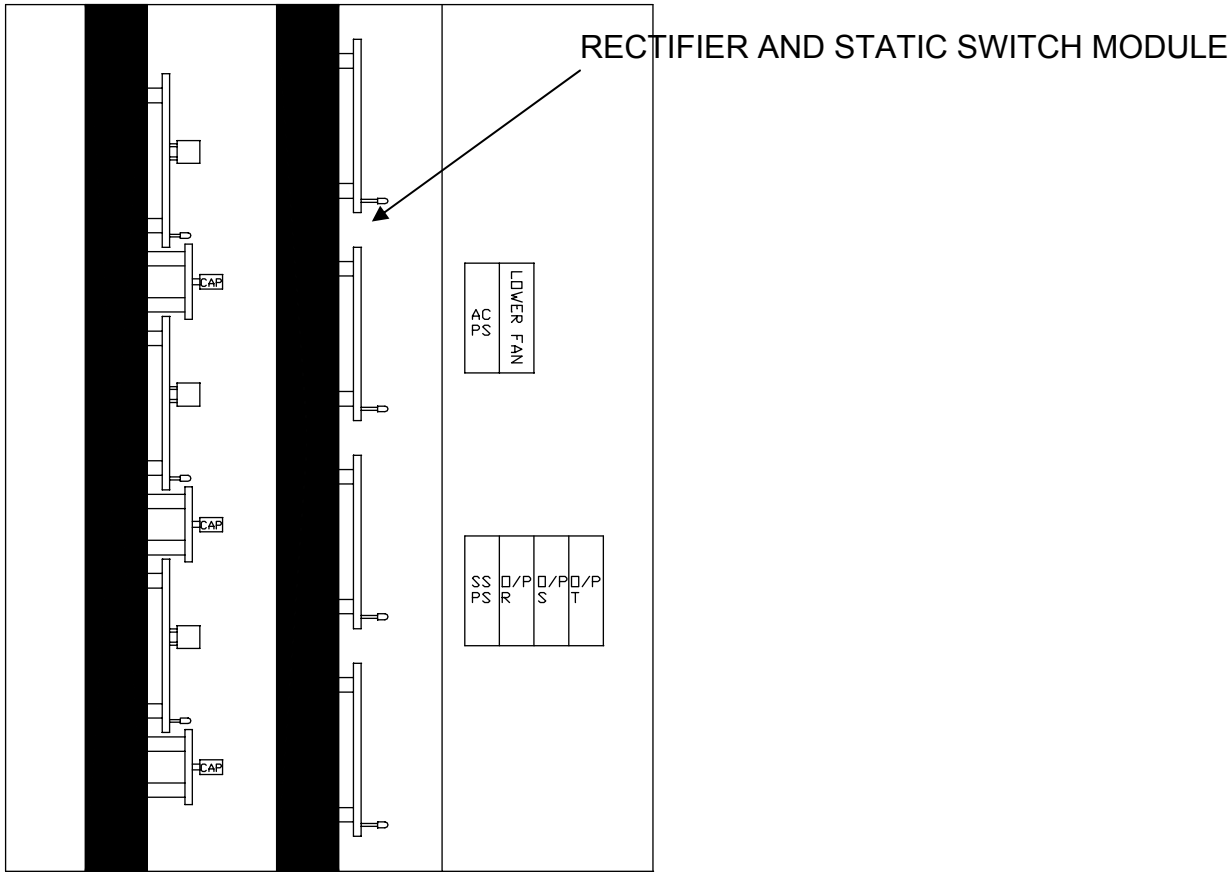


Figure 8.15
Location of Rectifier Module in the 8 to 48KW ELI System

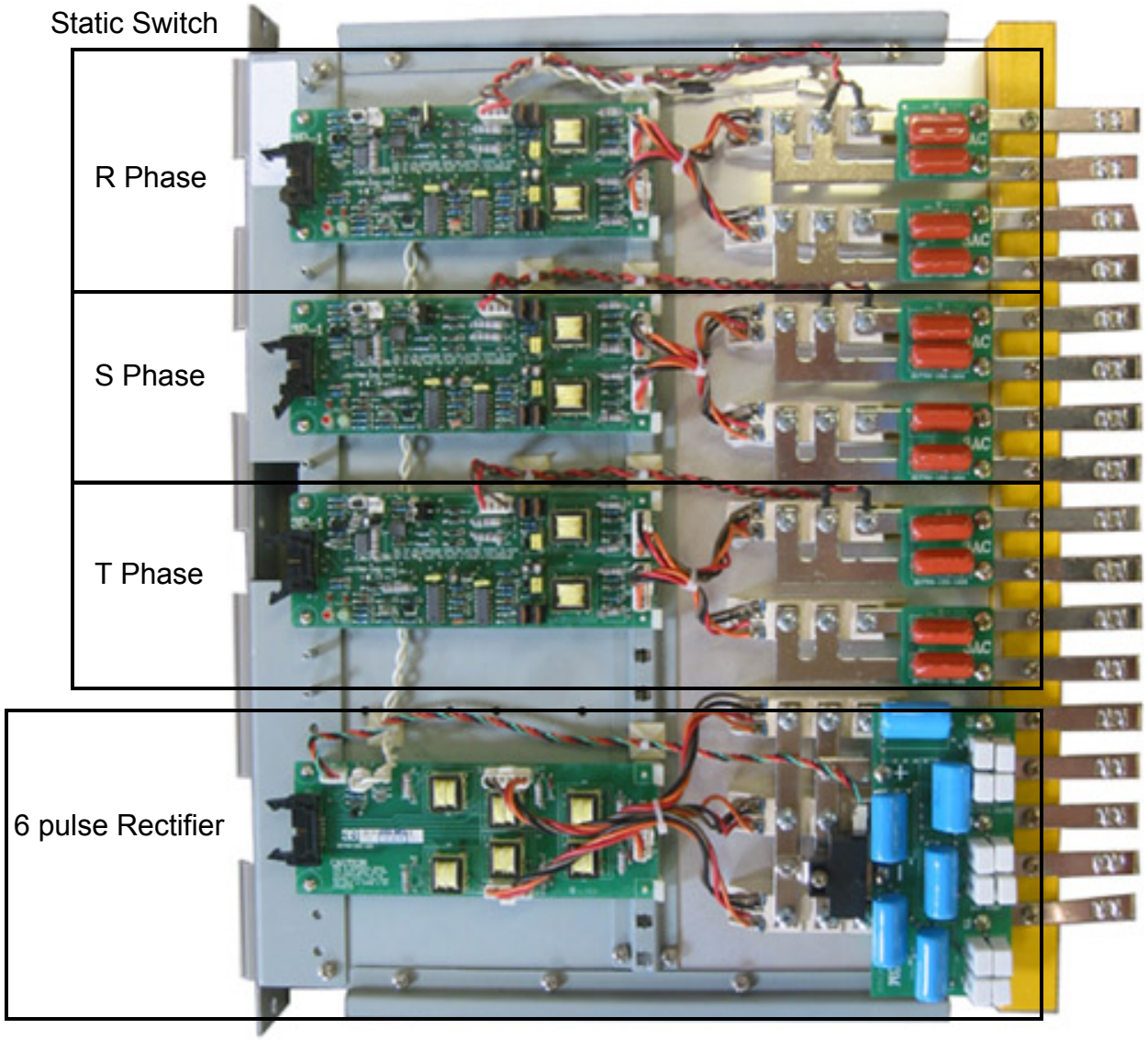


Figure 8.16
Picture of Rectifier and Static Switch Module for the 8 to 48KW ELI systems

Table 8.7 Operation for the 3S PCB

PCB	FUNCTION	LOCATION	NORMAL			ABNORMAL		SOLUTION
			PCB LED	LED Illumination	Description	LED Illumination	Description	
3S	Rectifier Drive	Rectifier Module					If DC bus can not be stabilized the AC output is transferred to the reserve automatically	Ensure cable connections are secure and correctly attached. The expected MTBF for this system is 3,000,000 minutes.
							If during operation, it transfer to back-up mode.	Check input and rectifier breaker are closed and input utility is present

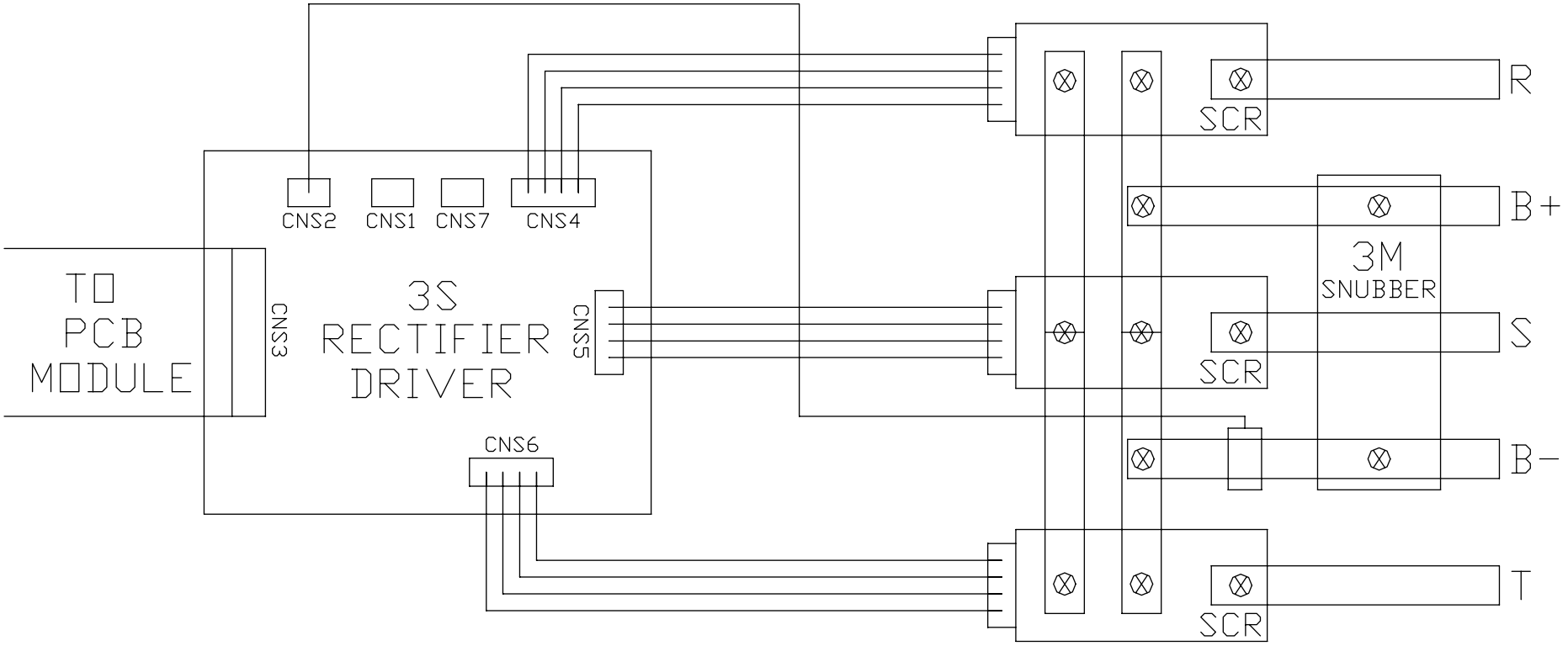


Figure 8.17
Layout of Rectifier Module (6-pulse)

8.12. Static Switch

This is a Pluggable Module, which is part of the Rectifier Module for the 8 to 48KW ELI systems containing the high power devices for the static switch. The static switch monitors the inverter and output, if a condition occurs (inverter shutdown or problem condition) it will transfer the output from the inverter to the reserve path automatically. When the condition has been cleared the static switch will automatically transfer power from the reserve path to the inverter.

One phase of the static switch is comprised of a Static Switch Control PCB (3P PCB), high powered, naturally commutated SCR's, and other monitoring and protecting components.

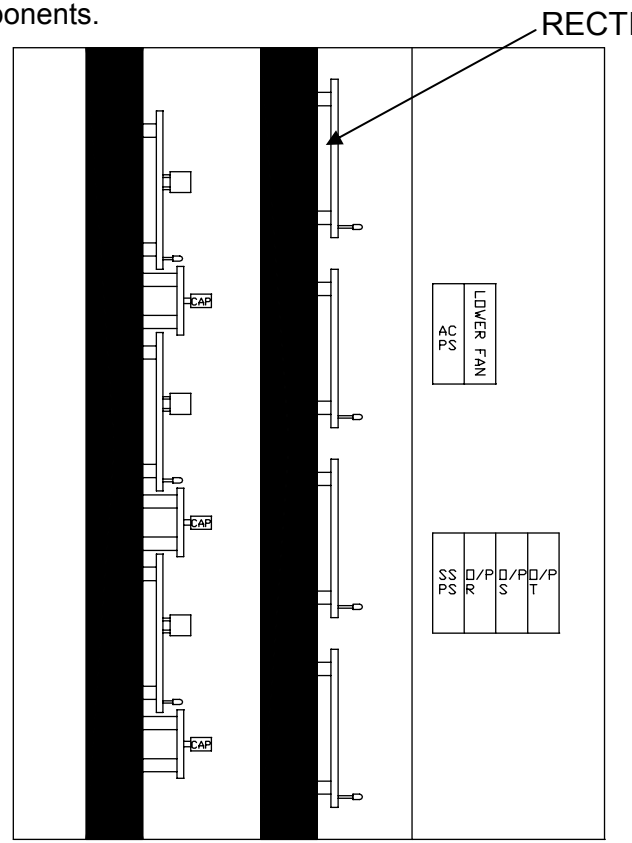


Figure 8.18
Location of Static Switch Module in the 8 to 48KW ELI system

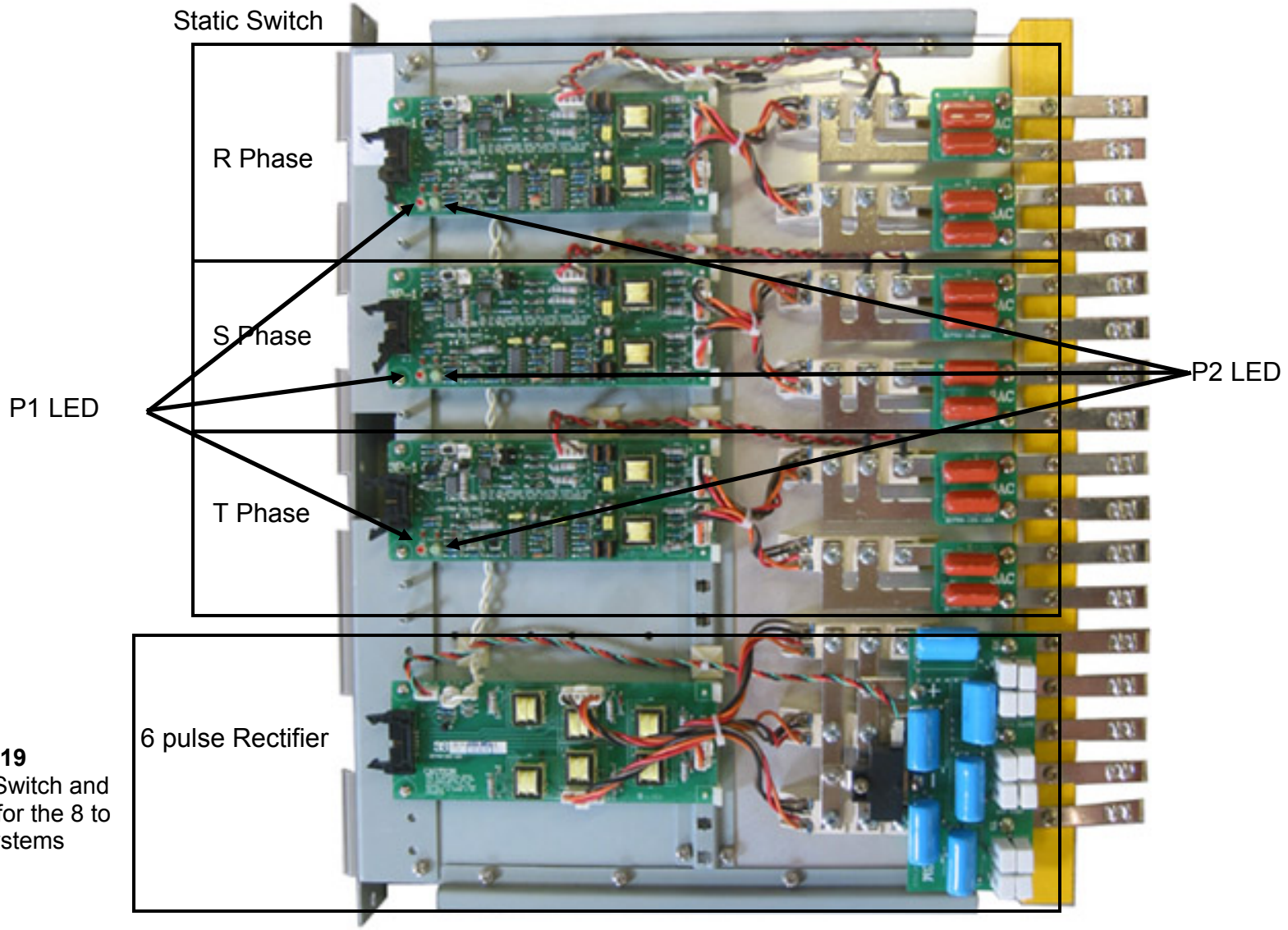


Figure 8.19
Picture of Static Switch and Rectifier Module for the 8 to 48KW ELI systems

Table 8.8 LED Operation for the 3P PCB

PCB	FUNCTION	LOCATION	NORMAL			ABNORMAL		SOLUTION
			PCB LED	LED Illumination	Description	LED Illumination	Description	
3P	Static Switch Driver (R,S,T)	Static Switch Module	LED P1	Yes	Inverter output is within normal parameters	No	Inverter operating, transfer from inverter has failed	Replace the board
			LED P2	Yes	Reserve output is within normal parameters	No	Inverter operating, transfer from reserve has failed	Replace the board

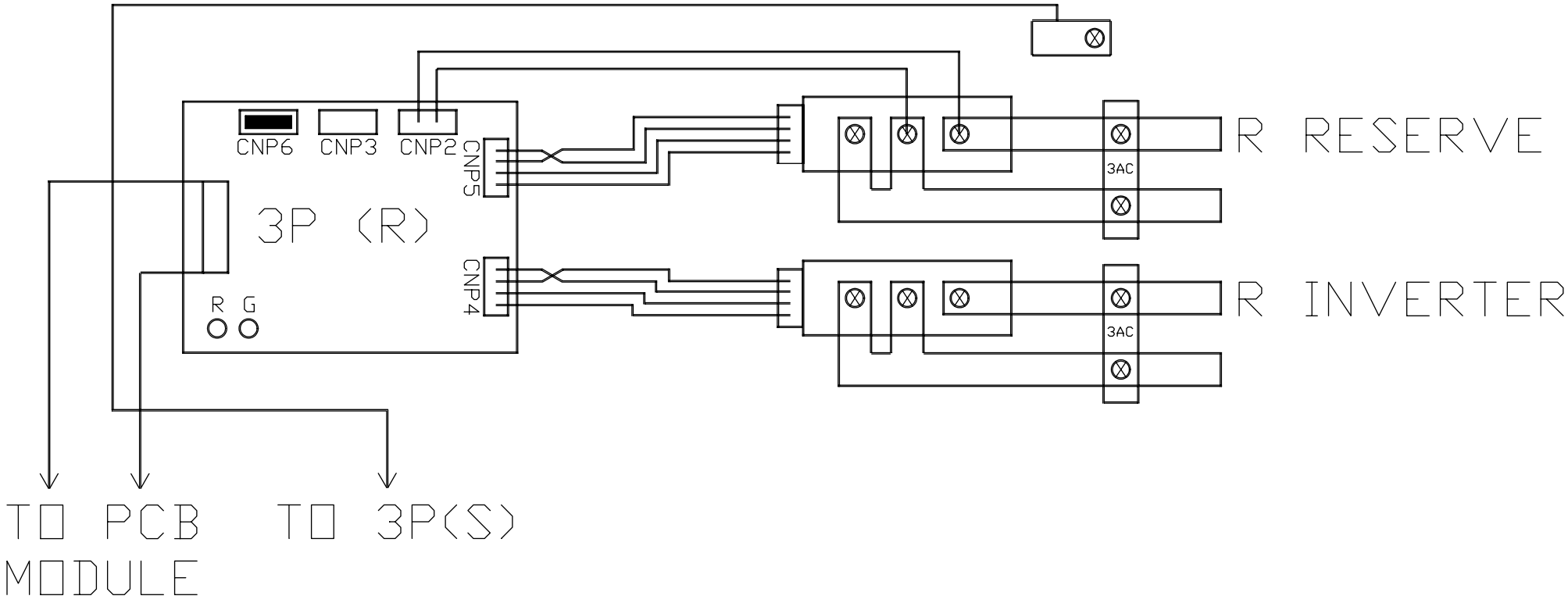
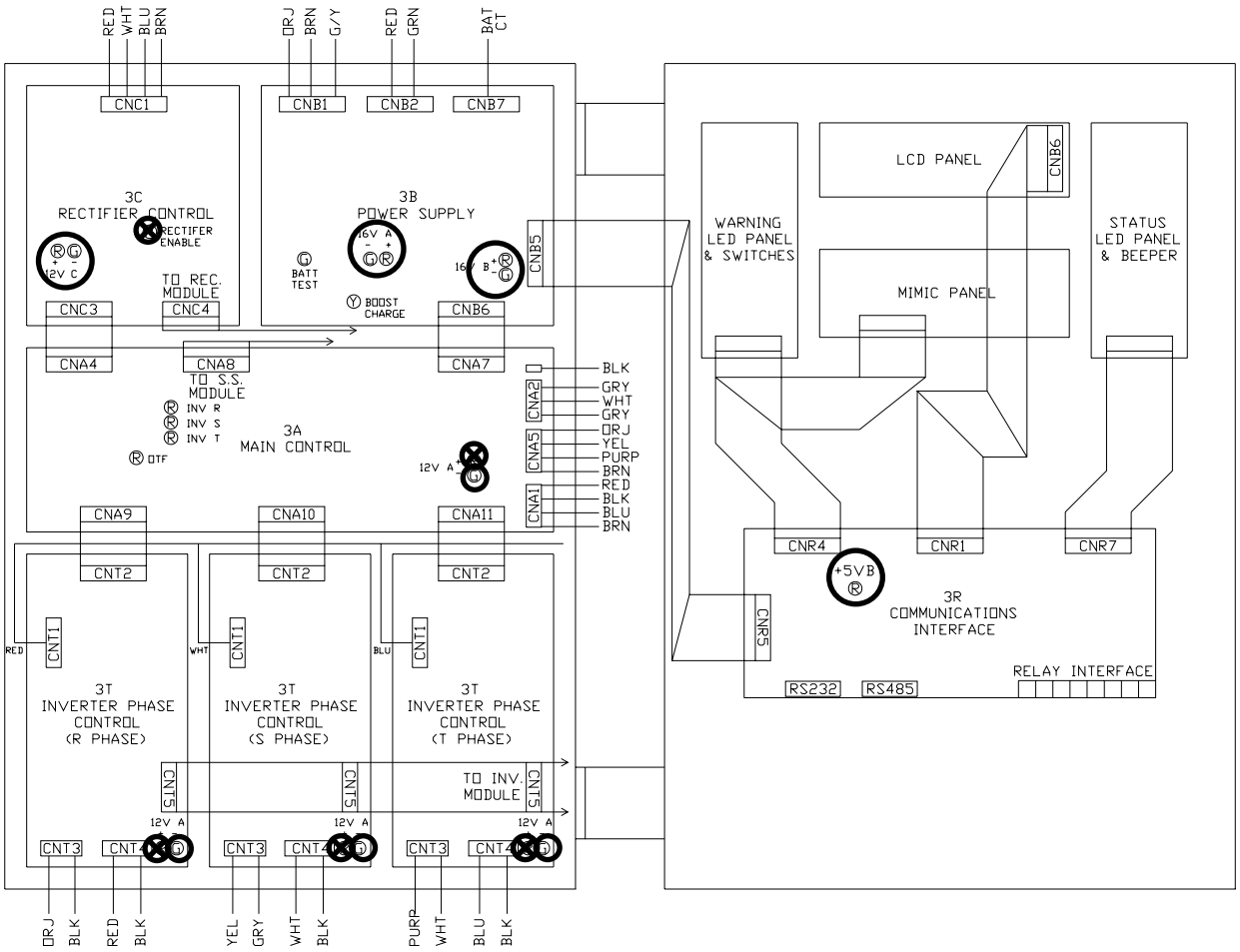
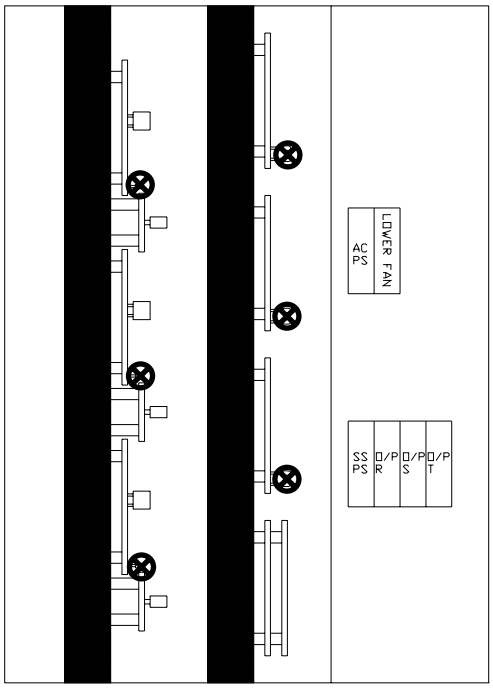


Figure 8.20
Layout of one phase of the Static Switch Module

9. BOARD FAULT DIAGRAMS

3A Board Fault

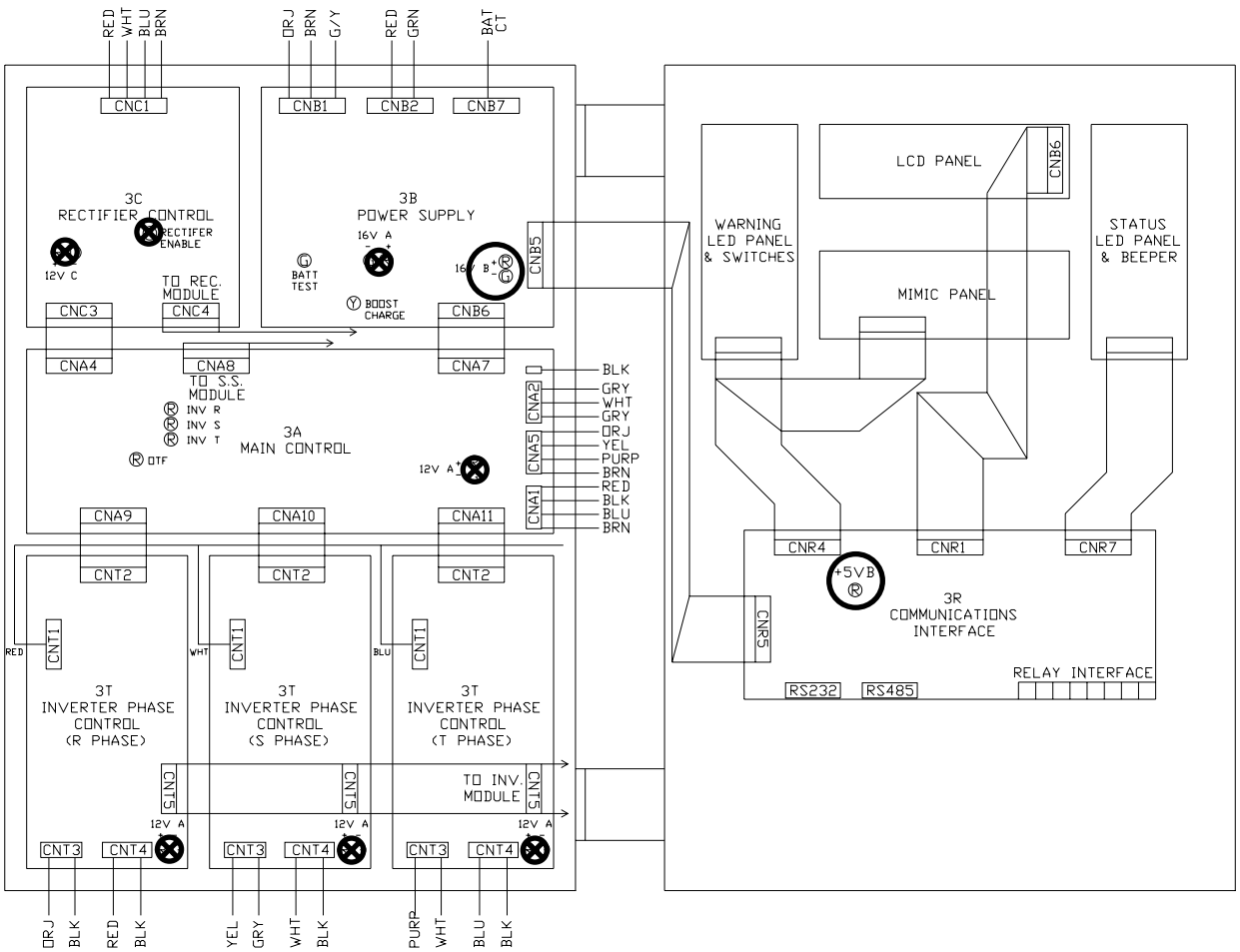


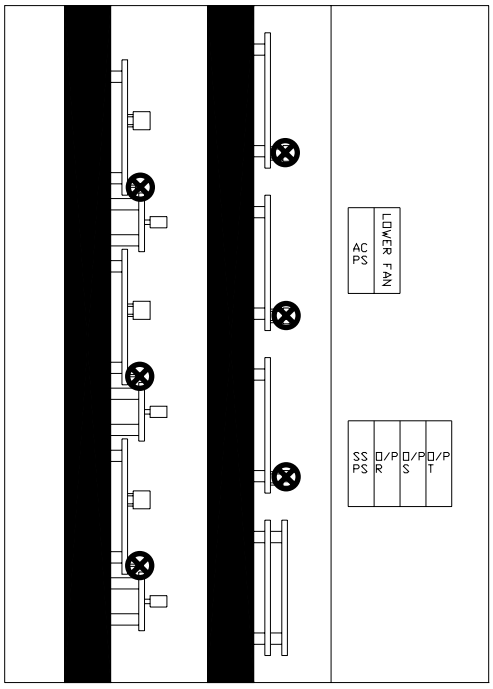


UPS will not start up. Once Reserve Breaker is closed all LED's on front display light up and LCD is non-functional.

Figure 9.1
3A Board Fault

3B Board Fault

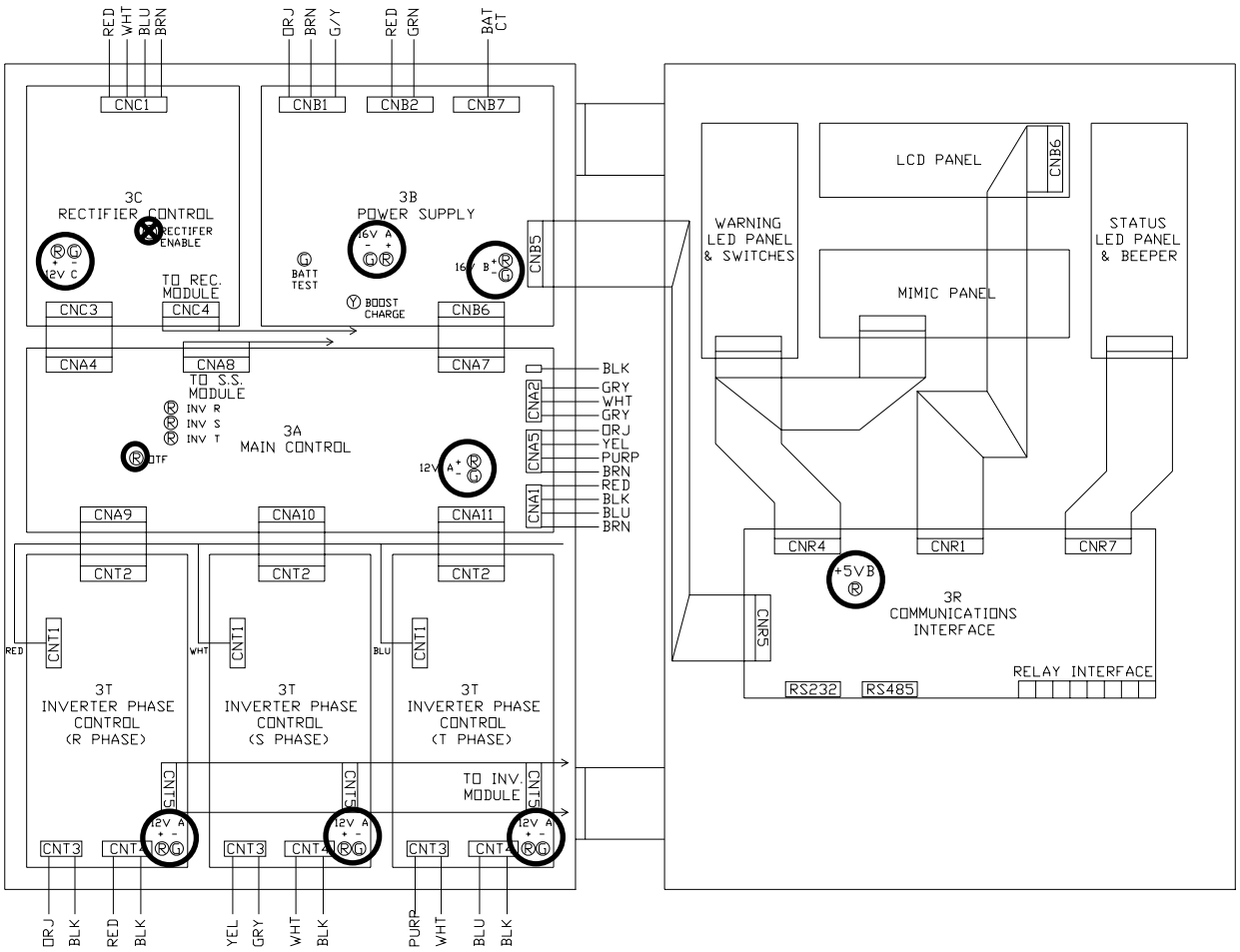


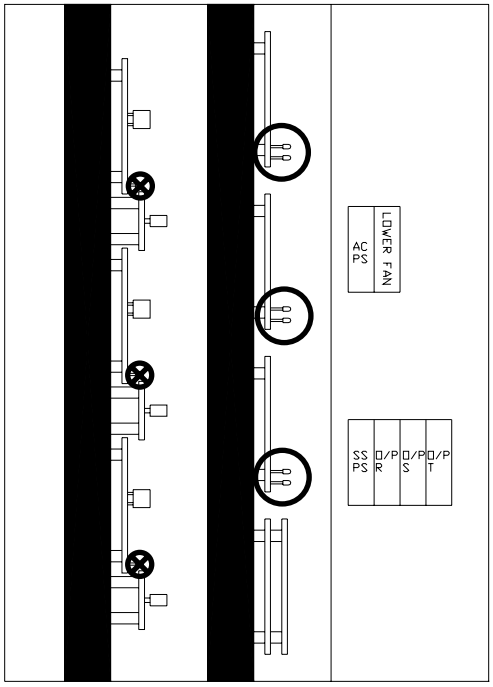


UPS will not start up. Once Reserve Breaker is closed all LED's on front display light up and LCD is non-functional.

Figure 9.2
3B Board Fault

3CC Board Fault

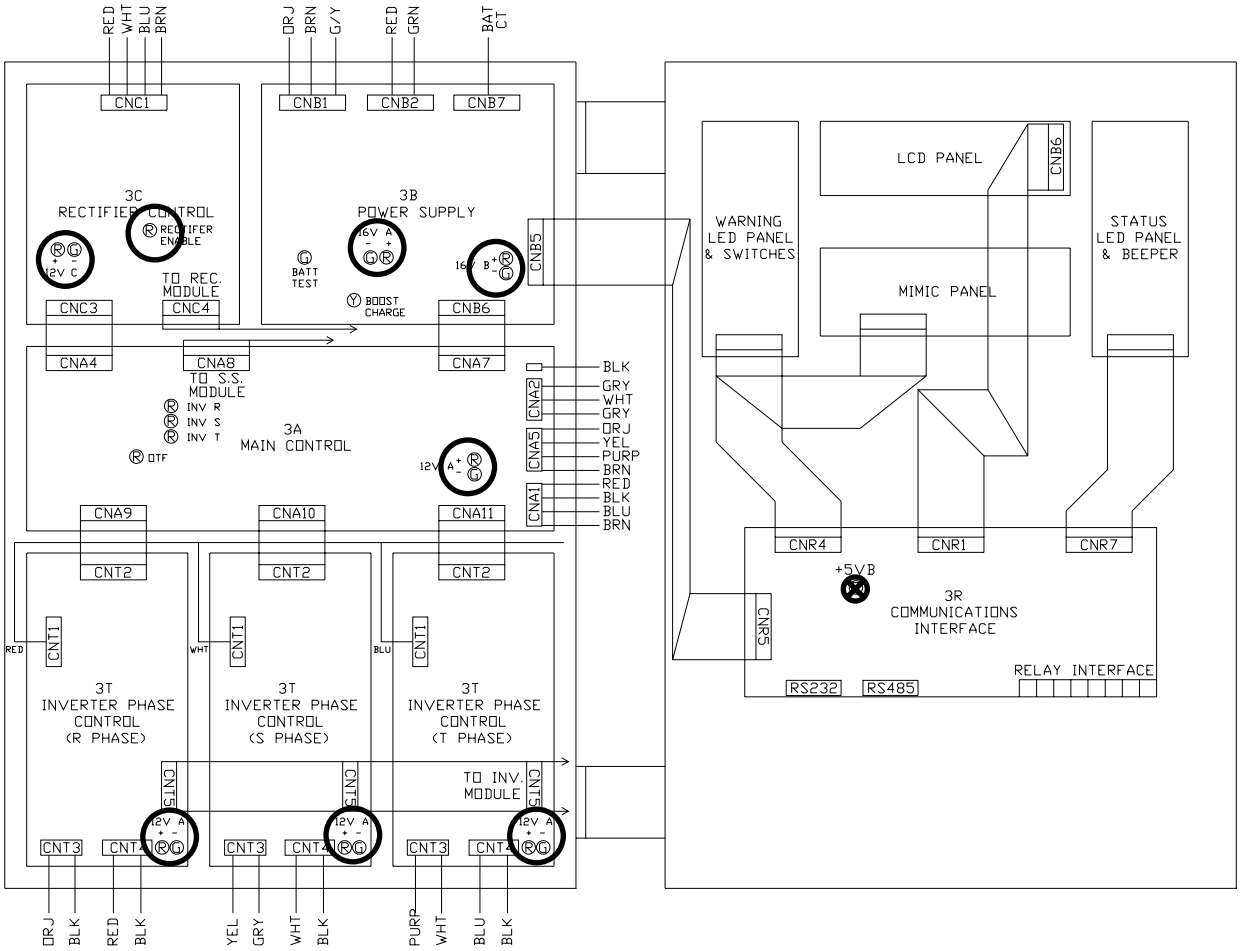


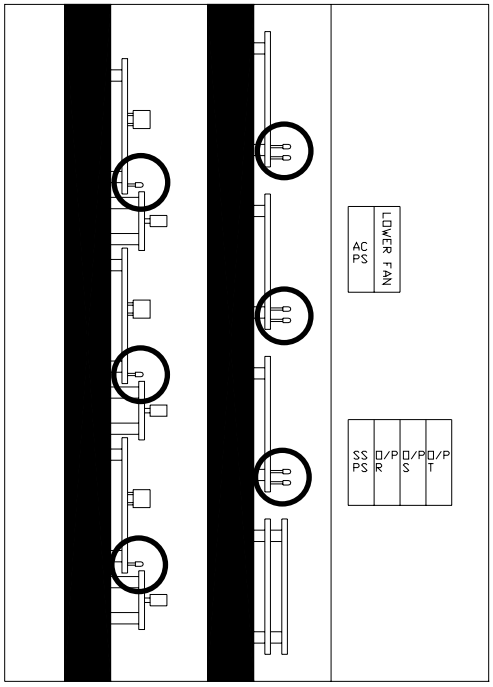


UPS will not start-up. Rectifer disabled. No DC Buss.

Figure 9.3
3CC Board Fault

3R Board Fault

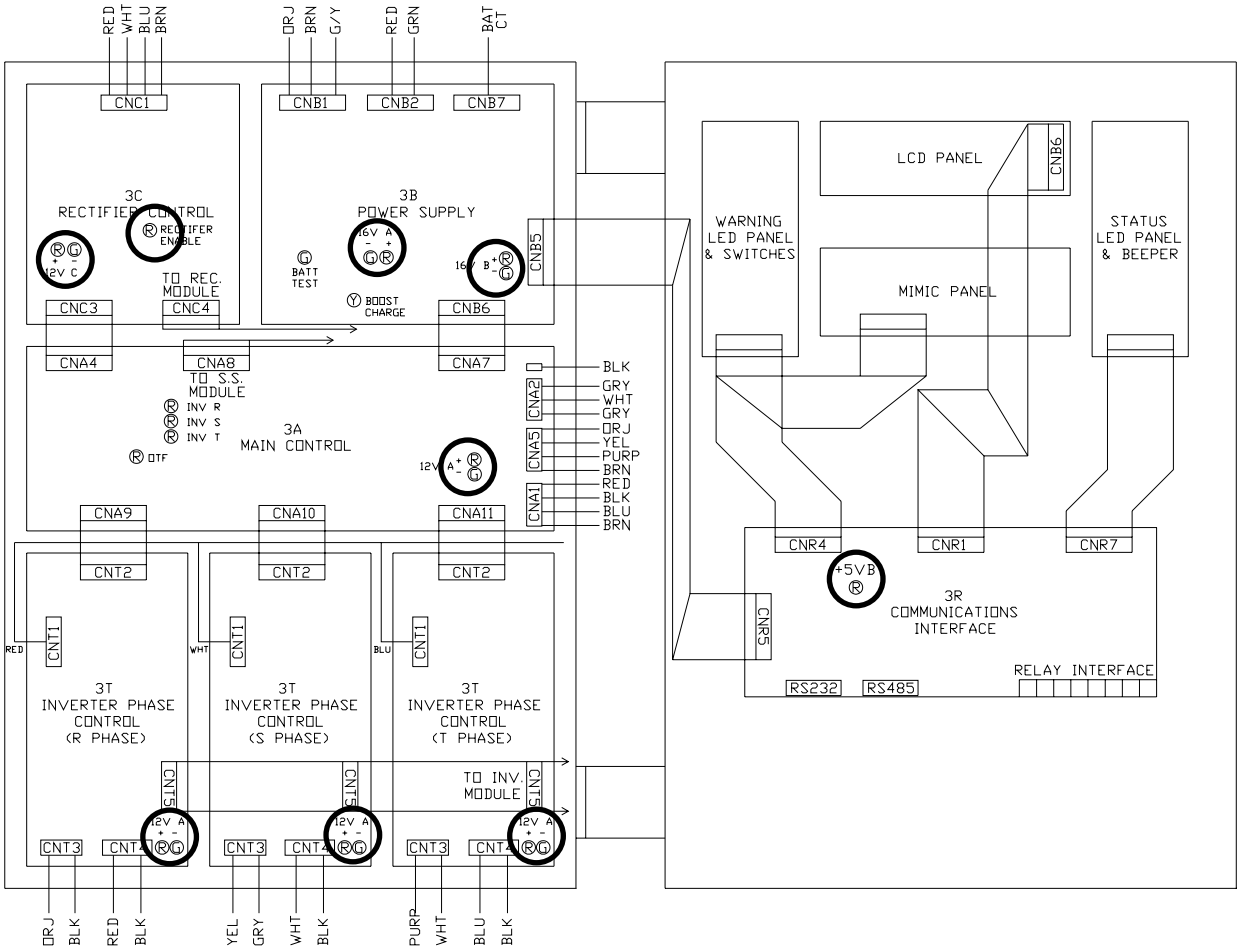


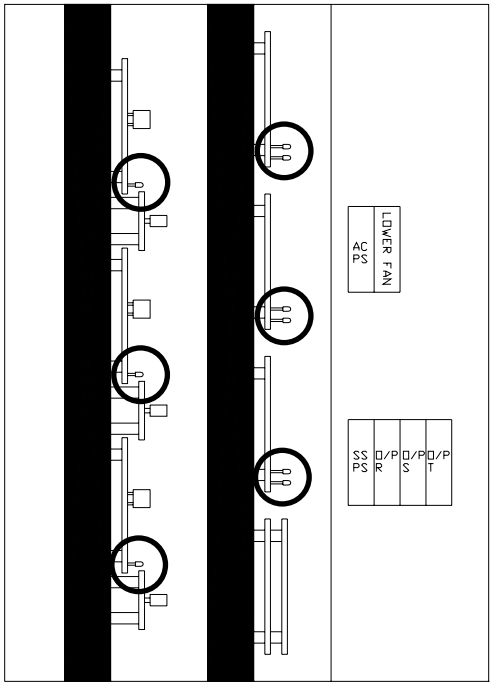


No front panel display and no communications. UPS starts up as per normal operation and inverter and rectifier function as per normal operation.

Figure 9.4
3R Board Fault

3T Board Fault A

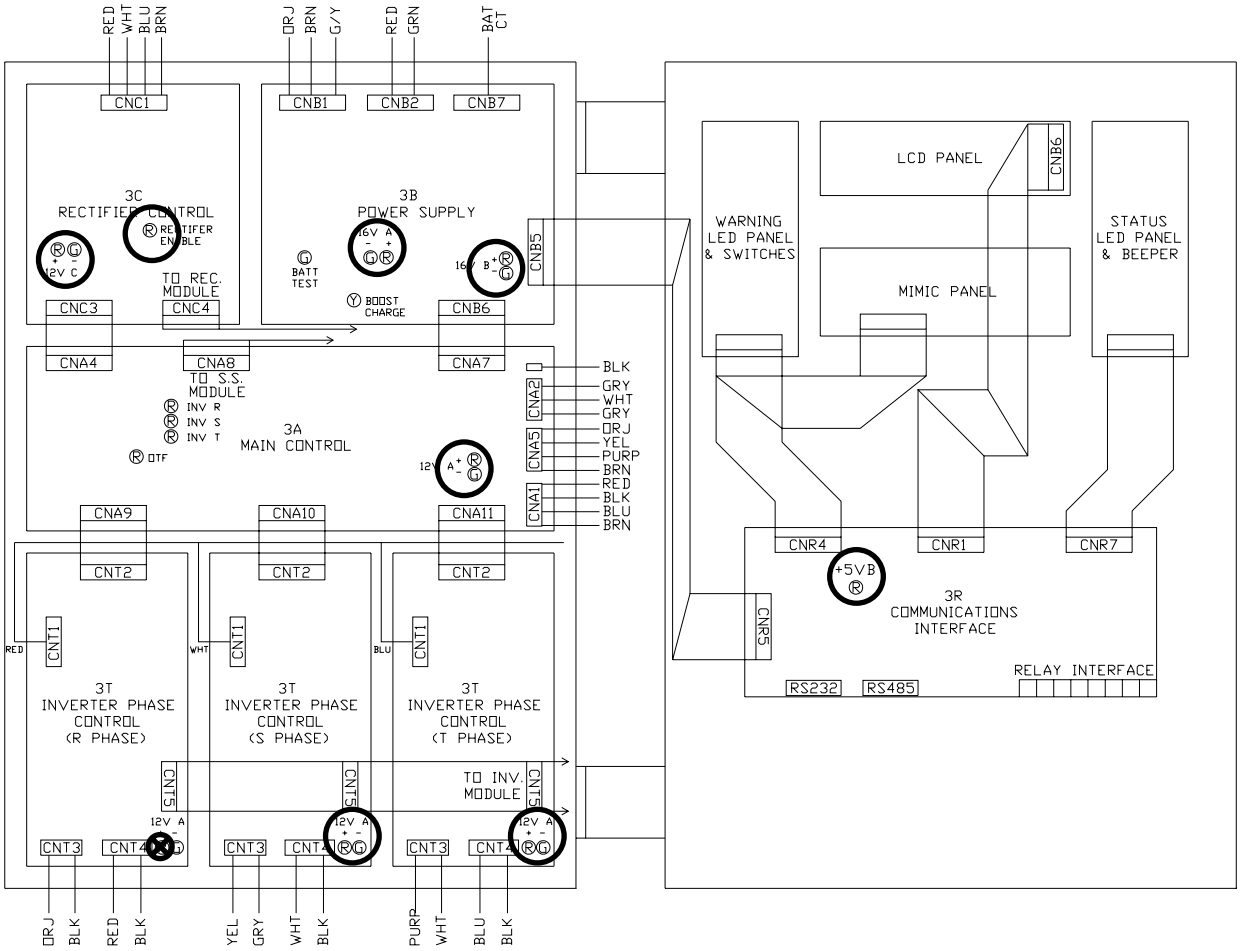


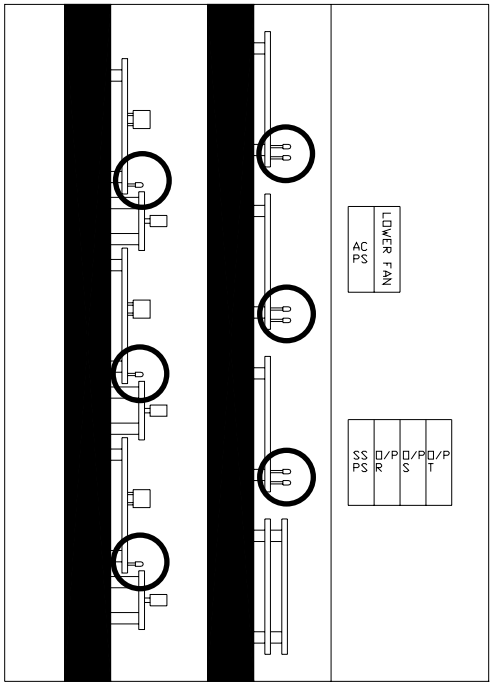


UPS system initializes ok. Once inverter attempts to assume load system beeps, “Inv Fail Shutdown” LED turns on, “Fault” LED turns on and “Load” LED flashes. System remains in Static Bypass mode, re-attempting Inverter start-up continually.

Figure 9.5
3T Board Fault A

3T Board Fault B

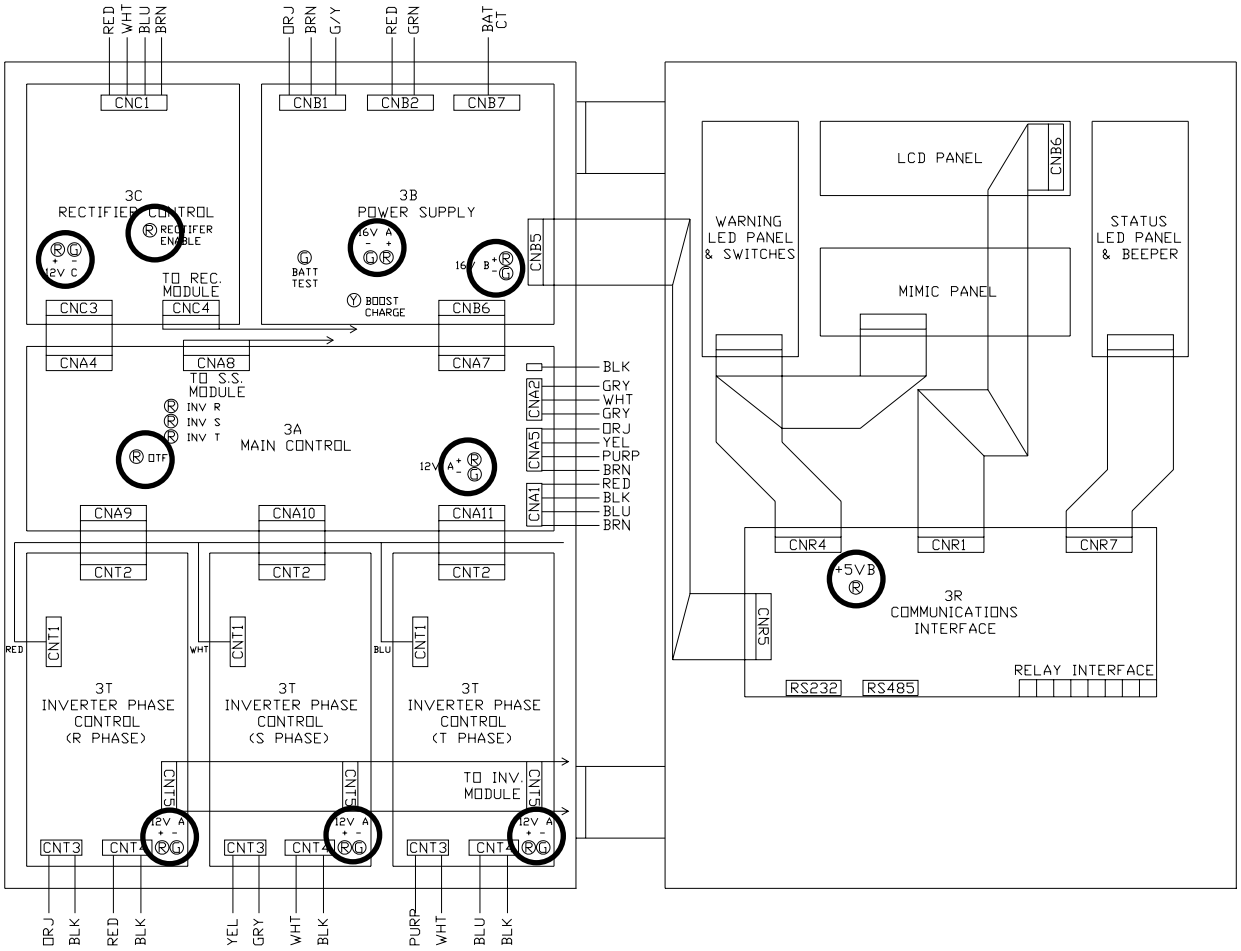


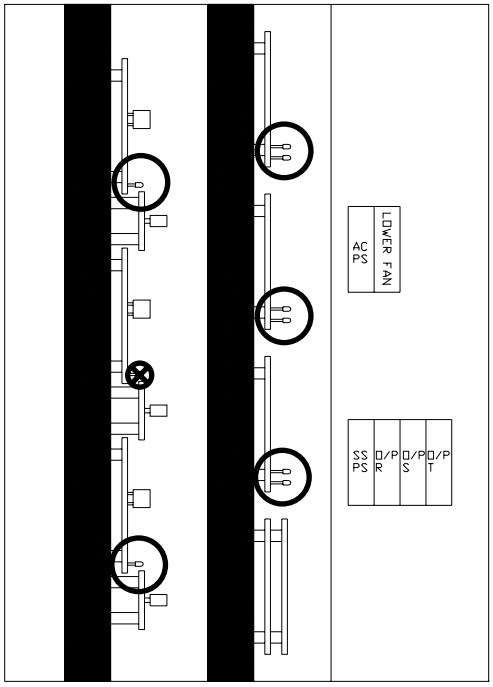


UPS system initializes ok. Once inverter attempts to assume load system beeps, “Inv Fail Shutdown” LED turns on and “Fault” LED turns on. System remains in Static Bypass mode.

Figure 9.6
3T Board Fault B

Inverter Module Fault

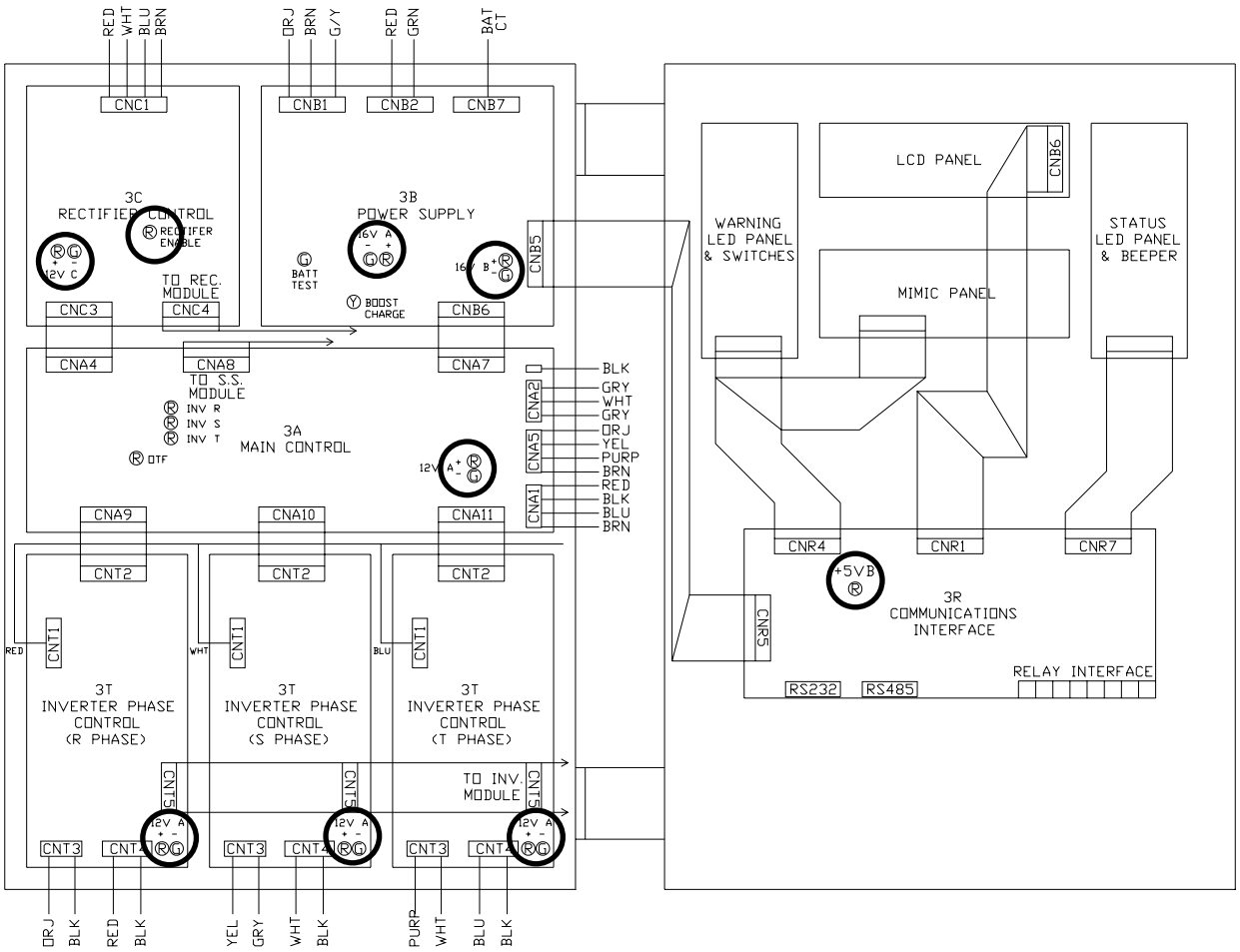


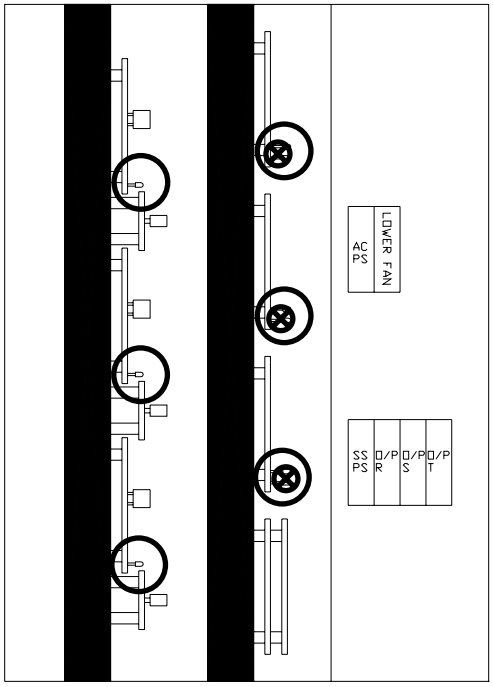


UPS system initializes ok. When DC Buss is established “Fuse/Temp” fault LED turns on. Inverter can not be turned on. System operates in Static bypass mode only.

Figure 9.7
Inverter Module Fault

Static Switch Module Fault





UPS starts up to full operation. When inverter is turned off UPS output shuts down because of faulty static switch.

Figure 9.8
Static Switch Module Fault

10. STATUS INDICATOR TABLE

Indicators: 1=On, 0=Off, R=Red, G=Green, x=On or Off	Reserve Breaker ON	Rectifier Breaker ON	Inverter ON	Inverter OFF	IP Breaker OFF	Fault Condition
REC AC FAIL	1	0	0	0	1	
RESERVE FAIL	0	0	0	0	1	
FUSE/TEMP	1	> 0	0	0	0	x
OVERLOAD	0	0	0	0	0	x
HIGH DC	0	0	0	0	0	x
BAT LOW	1	> 0	0	0	x	
BAT LOW STOP	1	> 0	0	0	x	
FAULT	0	0	0	0	0	1
INVERTER ON	0	0	1	0	1	
INVERTER SS	1	1	1	0	1	x
SHORT CIRCUIT	0	0	0	0	0	x
FUSE/OVER TEMP SD	0	0	0	0	0	x
INVERTER FAIL SHUTDOWN	0	0	0	0	0	x
BYPASS ON SHUTDOWN	0	0	0	0	0	x
HIGH DC SHUTDOWN	0	0	0	0	0	x
OVERLOAD SHUTDOWN	0	0	0	0	0	x
70% LOAD	0	0	x	x	x	x
110% LOAD	0	0	0	0	0	x
125% LOAD	0	0	0	0	0	x
150% LOAD	0	0	0	0	0	x
RESERVE AC FAIL	0	0	0	0	1	
RESERVE FREQ FAIL	0	0	0	0	1	
BATTERY LOW	1	> 0	0	0	x	
BATTERY LOW SHUTDOWN	0	0	0	0	x	
REC AC FAIL	1	0	0	0	1	
ROTATION ERROR	1	0	0	0	1	
RECTIFIER SHUTDOWN	0	0	0	0	0	x
HIGH DC	0	0	0	0	0	x
BOOST CHARGE	0	0	0	0	0	
BATTERY TEST	0	0	0	0	0	
EMERGENCY STOP	0	0	0	0	0	x
DATA LINE	x	x	x	x	x	x
INVERTER MODULE - R	0	> 1	1	1	1	x **
INVERTER MODULE - S	0	> 1	1	1	1	x **
INVERTER MODULE - T	0	> 1	1	1	1	x **
STATIC SW MODULE - R	R	R	R	G	R	x
STATIC SW MODULE - S	R	R	R	G	R	x
STATIC SW MODULE - T	R	R	R	G	R	x
3A - MAIN CONTROL - INV R	1	0*	0	0	0	x ***
3A - MAIN CONTROL - INV S	1	0*	0	0	0	x ***
3A - MAIN CONTROL - INV T	1	0*	0	0	0	x ***
3A - MAIN CONTROL - OTF	1	> 0	0	0	0	x
C - REC CONT - REC ENABLE	0	1	1	1	0	x
ALL PCBs - POWER STATUS	R + G	R + G	R + G	R + G	R + G	x

* Push OFF Button to reset Alarms

** 0 indicates faulted phase

*** 1 indicates faulted phase

11. BOARD LED INDICATION TABLE

PCB	FUNCTION	LOCATION	NORMAL			ABNORMAL		SOLUTION
			PCB LED	LED Illuminated	Description	LED Illuminated	Description	
3A	Main Control	PCB Module	LED A1 INV R	No	3T (R phase working)	Yes	R phase failure and UPS shutdown	Check 3T (R phase) ensure cable connections are secure and correctly attached. Replace the board
			LED A2 INV S	No	3S (S phase working)	Yes	S phase failure and UPS shutdown	Check 3T (S phase) ensuring cable connections are secure and correctly attached. Replace the board
			LED A3 INV T	No	3T (T phase working)	Yes	T phase failure and UPS shutdown	Check 3T (T phase) ensuring cable connections are secure and correctly attached. Replace the board
			LED A4 Overtemp Fault (OTF)	No	3G working	Yes	3G has problem	Check 3G and ensure cable connections are secure and correctly attached. Replace the board
			LED A5, A6 12VDCA	All Yes	PCB has power	No	PCB has no input power	Check 3B and ensure cable connections are secure and correctly attached. Replace the board
3B	Power Supply	PCB Module	LED B1, B2, B3, B4 (B1 and B3 16VDCA) (B2 and B4 16VDCB)	All Yes	PCB has power	No	LED's of PCB extinguished	Check fuse set behind PCB holder and ensure cable connections are secure and correctly attached. Replace the board
			LED B6 Batt Test	Yes	The system is testing the batteries			
			LED B7 Boost Charge	Yes	The system is boost charging the batteries.			
3C	Rectifier Control (It is separated into 3CC and 3CD board for the option of 12 pulse)	PCB Module	LED C1 Rectifier Enable	Yes	Rectifier Enabled	No	PCB has no input power or input power outside of operating parameters	Ensure cable connections are secure and correctly attached. Check the input power Replace the board
			LED C2, C3 12VDC	All Yes	PCB has power	All No	PCB has no input power	Ensure cable connections are secure and correctly attached. Replace the board
3T	Inverter Phase Control	PCB Module	LED T1, T2 12VDCA	All Yes	PCB has power	All No	R, S or T phase lost, output LED on the front panel (mimic diagram) blinks indicating lost phase.	Ensure cable connections are secure and correctly attached. Replace the board
3R	Communication Interface	PCB Module	LED R1 5VDCB	Yes	PCB has power	No	Interface communication failure	Ensure cable connections are secure and correctly attached. Replace the board
3G	Inverter Driver (RST)	Inverter Module	LED G1 Fuse Open Over Temp	Yes	Inverter working	No	Inverter failure	Ensure cable connections are secure and correctly attached. Replace the board
3P	Static Switch Driver (R,S,T)	Static Switch Module	LED P1 (RED) Inverter S.S.	Yes	Inverter output is within normal parameters	No	Inverter operating, transfer from inverter has failed	Replace the board
			LED P2 (GRN) Reserve S.S.	Yes	Reserve output is within normal parameters	No	Inverter operating, transfer from reserve has failed	Replace the board

12. Technical Specifications

8KW to 48KW ELI 3Ø Input - 3Ø Output

KW Rating	8	12	16	24	32	40	48
RECTIFIER							
Input Voltage	208V/480V/600V 3 phase 3 and 4 wire + G						
Input Range	180-750V						
Input Frequency	50 / 60 Hz +/- 7%						
Input Power Factor	< 1						
Normal Input Current(A) (Based on 208VAC)	33	49	66	99	132	165	198
Maximum Input Current(A) (Based on 208VAC)	45	63	83	125	160	200	250
Current THD	6 PULSE : 30% ; 12 PULSE :15% 12 PULSE WITH FILTER : 9%						
Power Walk In (adjustable)	0% - 100% : 20 sec						
Efficiency	99%						
Voltage Regulation	1%						
Ripple Voltage	0.5%						

BATTERY					
Battery Type	Maintenance free Sealed Lead Acid				
No. Of Cells	174				
Voltage Range	295 – 410VDC				
Maximum Charge Current (ADC)	10	15	20	25	30
Battery Low Voltage	320VDC				
Battery Low Stop Voltage	295VDC				
Boost Charge	410VDC				
Float Charge	396VDC				

KW Rating	**8**	**12**	**16**	**24**	**32**	**40**	**48**

INVERTER

DC Input Range		285 – 415VDC						
Wave Form		Sinusoidal						
Output Voltage (Adjustable)		120/208V 277/480V 347/600V 3 Phase 4 Wire + G						
Crest Factor		3 : 1						
Output Power Factor		0.8						
Voltage Regulation 100% Unbalance Load		+ / - 1 %						
Frequency Lock Range		45 – 55 Hz / 55 – 65 Hz						
Output Frequency (Free Running)		50 / 60 Hz + / - 0.1 Hz						
Output Voltage Tolerance	Static	+/- 1%						
	Load step 0% - 100% - 0%	+/- 3%, recovering to within +/- 1% in 1 cycle						
	Load step 0% - 50% - 0%	+/- 2%, recovering to within +/- 1% in 1 cycle						
	100% unbalanced load (Ph-N)	+/- 2.5%						
Phase Shift Under 100% Unbalance Load		120° + / - 0.5						
THD (Linear Load)		< 2 %						
Overload	- <110%	CONTINUOUS						
	- 110 – 125%	15 min						
	- 125 – 150%	10 min						
	- > 150%	60 sec						
Efficiency (100% Load)		93%	93%	93%	93%	93.5%	93.5%	94%
Maximum Output Wattage (kW)		8	12	16	24	32	40	48

STATIC SWITCH

Voltage Range		+- 20% of input voltage (Line to Neutral)
Frequency Range		45 – 55 Hz / 55 – 65 Hz
Efficiency		99.5%
Transfer Time	- Mains -> Inverter	0 ms
	- Inverter -> Mains	0 ms
Overload	- 100%	30 sec
	- 300%	1 sec
Isolation With Output		YES

KW Rating	**8**	**12**	**16**	**24**	**32**	**40**	**48**

OVERALL CHARACTERISTICS

Overall Efficiency	91%	91%	91%	91%	91.5%	92%	92%
Operating Environment:							
- Temperature	0 – 40°C (32 – 104°F)						
- Humidity	0% - 95% (non–condensing)						
- Altitude	<1500 m above sea level						
Maximum Heat Dissipation(kW)	1.2	1.2	1.3	1.9	2.6	3	3.5
Weight(kg)	250	275	300	400	480	550	680
Dimension:							
- HEIGHT(mm)	1600						
- WIDTH(mm)	559						
- DEPTH(mm)	815						
- Audible Noise	< 65 dBA (AT 1 m)						
Standards:							
- CSA	Yes						
- CE	Yes						
- EN50091-1,-2	Yes						
- FCC Part 15 Class A	Yes						
Protections:							
- Short Circuit	Rectifier, Reserve, Bypass NFB						
- Lightning	MOV						
- EMC Filter	Input & Output						
- Galvanic Isolation	Between Input & Output						
Data Display By LCD	Yes						
Indications & Alarms:							
- LED, LCD, Buzzer	Yes						
Dry Contact	Yes						
Battery Start	Yes						

All specifications mentioned above are subject to change without prior notice.

Specification Table for Three Phase Inverters

Model Size	8kW	12kW	16kW	24kW	32kW	40kW	48kW
Output Power Factor	0.8						
Input // Output Voltage Combinations Available 3 phase	208/120 // 208/120 480/277 // 208/120 600/347 // 208/120 208/120 // 480/277 480/277 // 480/277 600/347 // 480/277 208/120 // 600/347 480/277 // 600/347 600/347 // 600/347						
AC Input Voltage- Input Service Amps	208/120V – 50A 480/277V – 20A 600/347V – 15A	208/120V – 70A 480/277V – 30A 600/347V – 30A	208/120V – 90A 480/277V – 40A 600/347V – 30A	208/120V – 125A 480/277V – 60A 600/347V – 50A	208/120V – 175A 480/277V – 80A 600/347V – 60A	208/120V – 225A 480/277V – 100A 600/347V – 80A	208/120V – 250A 480/277V – 125A 600/347V – 90A
Output Voltage and Maximum Output Current in Amperes at 100% Load	208/120V – 22.3A 480/277V – 9.7A 600/347V – 7.7A	208/120V – 33.4A 480/277V – 14.5A 600/347V – 11.6A	208/120V – 44.5A 480/277V – 19.3A 600/347V – 15.4A	208/120V – 66.7A 480/277V – 28.9A 600/347V – 23.1A	208/120V – 88.9A 480/277V – 38.5A 600/347V – 30.8A	208/120V – 111.1A 480/277V – 48.2A 600/347V – 38.5A	208/120V – 133.3A 480/277V – 57.8A 600/347V – 46.2A
Standard Charger Size (amps)	10	10	10	15	20	25	30
DC System Voltage	348VDC nominal						

13. Battery Backup Units (BBU)

The battery cabinets have been designed with the same style and appearance as the ELI cabinet for ease of installation and cosmetic value. Reinforcement has been added to strengthen the cabinet for the additional weight and transportation. The Battery Banks contain the batteries and provide the runtime for the ELI system.

Physicals for 3 Ø Battery Cabinet
3 Ø: Width – 1321mm, Depth – 864mm and Height – 1930mm

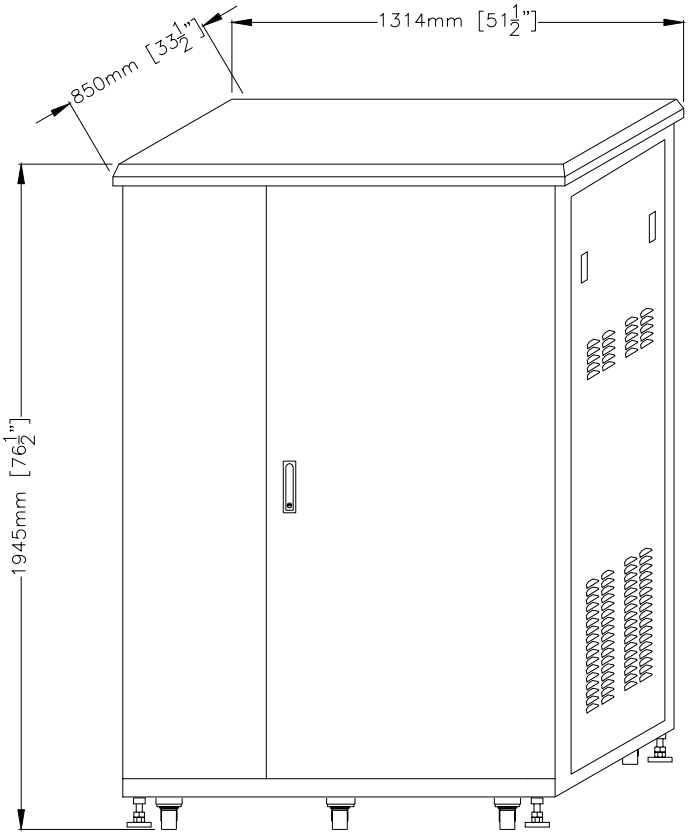


Figure 13.1
3 Phase Battery Cabinet Layout

Battery cabinets feature slide-out shelves. Prior to installation of the BBU, the side panels should have been removed and the screws holding the battery slide-out shelves in place should have been unscrewed, allowing for ease of battery replacement.

CAUTION! Only qualified service personnel should attempt battery bank maintenance. Removal of the side access panels exposes personnel to potential dangerous voltages and shock hazards that may cause damage, injury or death.

If screws have not been properly removed prior to BBU installation, completely shut down ELI, wait for 30 minutes until capacitors have fully discharged and disconnect ELI from BBU prior to servicing.

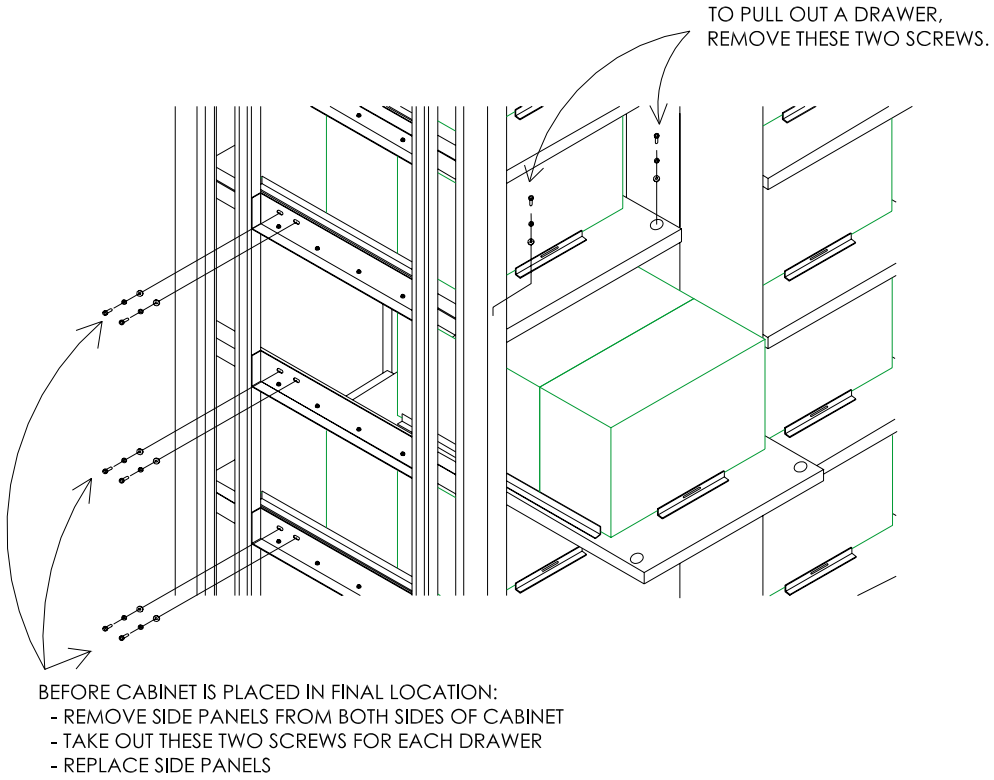

TO PULL OUT A DRAWER,
REMOVE THESE TWO SCREWS.
BEFORE CABINET IS PLACED IN FINAL LOCATION:
- REMOVE SIDE PANELS FROM BOTH SIDES OF CABINET
- TAKE OUT THESE TWO SCREWS FOR EACH DRAWER
- REPLACE SIDE PANELS

Figure 13.2
Slide-out BBU shelves

14. Contact Information

QA / Warranty Questions

Always On UPS Systems Inc.
Bldg 1 – 150 Campion Road,
Kelowna, BC, Canada, V1X 7S8
Phone: (250) 491-9777 Ext 209
Fax: (250) 491-9775
Email: qa@alwayson.com
Website: www.alwayson.com

Software Questions

Always On UPS Systems Inc.
Bldg 1 – 150 Campion Road,
Kelowna, BC, Canada, V1X 7S8
Phone: (250) 491-9777 Ext 204
Fax: (250) 491-9775
Email: webmaster@alwayson.com
Website: www.alwayson.com

Additional Purchases or Upgrades

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